

THE BROOK AND ITS BANKS



NEW EDITION
WITH FULL PAGE PLATES AND
OTHER ILLUSTRATIONS

BY THE LATE
REV J G WOOD M.A.

Lady Jane Hamilton's School.

Class I. Senior Division.

Drawing Prize.

Awarded to:-

Alexander Henderson.

24th June 1909.



THE BROOK AND ITS BANKS



The Haunt of the Kingfisher.

(See page 60.)

THE BROOK AND ITS BANKS

BY THE LATE REV.

J. G. WOOD, M.A.

AUTHOR OF 'THE HANDY NATURAL HISTORY'
ETC., ETC.

*WITH TWENTY-FOUR FULL-PAGE AND
FORTY FIVE OTHER ILLUSTRATIONS*

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PREFACE

THIS was one of the last works from the facile pen of the late Rev. J. G. Wood. It will be found in every way worthy of the reputation of the author.

The plan of the book is worked out with all the vivacity of style and copiousness of anecdote and personal experience for which Mr. Wood was so justly noted. The reader is conducted along the banks of an English brook, and taught in the pleasantest of ways, and by some charmingly-written descriptions, how to discover and observe the many living creatures which may be found either in the water or along the banks.

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The Babbling Brook.

THE BROOK AND ITS BANKS

CHAPTER I

ON BROOKS IN GENERAL

*Whyles owre a linn the burnie plays,
As through the glen it dimpl't;
Whyles round a rocky scaur it strays;
Whyles in a weil it dimpl't;
Whyles glittered to the nightly rays,
Wi' bickering, dancing dazzle;
Whyles cookit underneath the braes
Below the spreading hazel.*

BURNS—*Halloween.*

A BROOK has many points of view, and scarcely any two spectators see it in the same light.

To the rustic it is seldom more than a convenient water-tank, or, at most, as affording some sport to boys in fishing. To its picturesque beauties his eyes are blind, and to him the brook is, like Peter Bell's primrose, a brook and nothing more. Then there are some who only view a brook as affording variety to the pursuit of the fox, and who pride themselves on their knowledge of the spots at which it can be most successfully leaped. Others, again, who are of a geographical turn of mind, can only see in a brook a necessary portion of the watershed of the district.

To children it is for a time dear as a playground, possessing the inestimable advantage of enabling them to fall into it and wet their clothes from head to foot.

Then there are others who are keenly alive to its changing beauties, and are gifted with artistic spirit and power of appreciation, even if they are not able to cultivate the technical skill which would enable them to transfer to paper or canvas the scene which pleases them. Yet they can only see the surface, and take little, if any, heed of the wealth of animated life with which the brook and its banks are peopled, or of the sounds with which the air is filled.

Happy are those in whom are fortunately combined the appreciation of art and the gift (for it is a gift as much as an eye for art or an ear for music) of observing animal life. To them the brook is all that it is to others, and much besides. To them the tiniest brook is a perpetual joy, and of such a nature I hope are those who read these pages.

Not only does a brook assume different aspects, according to the individuality of the spectator, but every brook has its individuality, and so have its banks. Often the brook 'plays many parts,' as in Burns's delightful stanza which stands at the head of this chapter, and which seems to have rippled from the poet's brain as spontaneously as does its subject from the source.

Sometimes, however, the brook flows silently onwards with scarcely a dimple on its unruffled surface. Over its still waters the gnats rise and fall in their ceaseless dance. The swift-winged dragon-flies, blue, green, and red, swoop upon them like so many falcons on their

prey; or, in the earlier year, the mayflies flutter above the stream, leaving their shed skins, like ghostly images of themselves, sticking on every tree-trunk near the brook. On the surface are seen the shadow-like water-gnats, drifting with apparent aimlessness over the surface, but having in view a definite and deadly purpose, as many a half-drowned insect will find to its cost.

Under the shade of the willows that overhang its banks the whirligig beetles will gather, sociably circling round and round in their mazy dance, bumping against each other in their swift course, but glancing off unhurt from the collision, protected from injury by the stout coats of mail which they wear. They really look like unskilful dancers practising their 'figures' for the first time. They, however, are not engaged in mere amusement, but, like the water-gnats, are absorbed in the business of life. The naturalist knows, when he sees these creatures, that they do not form the hundredth part of those which are hidden from human eyes below the surface of the little brook, and that the whole of the stream is as instinct with life as if it were haunted by the Nipens, the Undines, and the host of fairy beings with whom the old legends peopled every river and its tributaries. They are just as wonderful, though clad in material forms, as any water spirit that ever was evolved from the poet's brain, and have the inestimable merit of being always within reach whenever we need them.

I will venture to assert that no fairy tales, not even excepting those of the *Arabian Nights*, can surpass in marvel the true life-history of the mayfly, the frog, the newt, and the dragon-fly, as will be narrated in the

course of these pages. I may go even farther, and assert that there is no inhabitant of the brook and its banks whose biography and structure are not full of absorbing interest, and will not occupy the longest life, if only an attempt be made to study them thoroughly.

An almost typical example of slow-flowing brooks is to be found in the remarkable channels which intersect the country between Minster and Sandwich, and which, on the Ordnance map, look almost like the threads of a spider's web. In that flat district, the fields are not divided by hedges, as in most parts of England, or by stone walls—'dykes,' as they are termed in Ireland—such as are employed in Derbyshire and several other stony localities, but by channels, which have a strong individuality of their own. Even the smallest of these brooks is influenced by the tide, so that at the two periods of slack water there is no perceptible stream.

The contrast between these streams and their banks at Minster, and the corresponding brooklets of Oxford, also a low-lying district, is very strongly marked. In the first place, the willow, which forms so characteristic an ornament of the brooks and rivers of Oxford, is wholly absent. Most of the streamlets are entirely destitute of even a bush by which their course can be marked; so that when, as is often the case, a heavy white fog overhangs the entire district, looking from a distance as if the land had been sunk in an ocean of milk, no one who is not familiarly acquainted with every yard of ground could make his way over the fields without falling into the watery boundaries which surround them.

Some of them, however, are distinguished by hawthorns, which take the place of the willows, and thrive

so luxuriantly that they may lay claim to the title of forest trees. Blackberries, too, are exuberant in their growth, and in many spots the hawthorn and blackberry on opposite sides of the brook have intertwined their branches across it and have completely hidden the water from sight. On these blackberries, at the time of our visit, the fruit of which was in its green state, the drone-flies and hawk-flies simply swarmed, telling the naturalist of their multitudinous successors, who at present are in the preliminary stages of their existence.

Among the blackberries the scarlet fruit of the woody nightshade (a first cousin of the potato) hung in tempting clusters. In some cases the common frog-bit had grown with such luxuriance that it had completely hidden the water, the leaves overlapping each other, as if the overcrowded plants were trying to shoulder their neighbours out of the way.

In most of these streamlets the conspicuous bur-reed (*Sparganium ramósum*) grew thickly, its singular fruit being here and there visible among the sword-like leaves. I cannot but think that the mediaeval weapon called the 'morning star' (or *morgen-stern*) was derived from the globular, spiked fruit-cluster of the bur-reed.

A few of the streams were full of the fine plant which is popularly known by the name of bull-rush, or bulrush (*Typha latifolia*), but which ought by rights to be called the 'cat's-tail' or 'reed-mace.' Of this plant it is said that a little girl, on seeing it growing, exclaimed that she never knew before that sausages grew on sticks. The teasel (*Dipsacus*) was abundant, as were also several of the true thistles.

In some places one of these streams becomes too deep for the bur-reed, and its surface is only diversified by the half-floating leaves of one or two aquatic plants. On approaching one of these places, I found the water to be apparently without inmates. They had only been alarmed by my approach, which was not as cautious as it ought to have been. However, I remained perfectly still, and presently a little fish appeared from below. It was soon followed by a second and a third, and before long a whole shoal of fish were floating almost on the surface, looking out for insects which had fallen into the water. The day being hot, and with scarcely a breath of wind, the fish soon became quite bold. They did not move beyond the small spot in which they had appeared, but they all had their tails in slight movement, and their heads in one direction, thus showing that, although the water appeared to be perfectly motionless, there must be a current of some sort, fish always lying with their heads up the stream, so as to allow the water to enter their mouths and pass over their gills.

If then these sluggish streams were unlike those of Oxford, where the ground is low and nearly level, how utterly distinct must they be from those of hilly and especially of rocky localities! A few years ago I was cursorily examining a brook in Cannock Chase, in Staffordshire. Unfortunately, the day was singularly inauspicious, as the sun was invisible, the atmosphere murky, and a fierce north-east wind was blowing, a wind which affects animals, and especially the insect races, even more severely than it does man. Even the birds remain under shelter as long as they can, and

not an insect will show itself. Neither, in consequence, will the fish be 'on the feed.' On a previous visit, I had been more fortunate, trout, crayfish, &c., testifying to the prolific character of the brook, which in one place is only four or five feet in width; and yet, within fifty yards, it has formed itself into a wide and treacherous marsh, which can only be crossed by jumping from one tussock of grass to another; and yet again, it suddenly spreads out into a broad and shallow torrent, the water leaping and rippling over the stony bed. Scarcely a bush marks its course, and within a few yards it is quite invisible.

As we shall presently see, the brooks of the chalk downs of Wiltshire, and of the regular mixture of rock and level ground which is characteristic of Derbyshire, have also their own separate individualities. We shall, however, find many allusions to them in the course of the work, and we will therefore suppose ourselves to be approaching the bank of any brook that is but little disturbed by man. What will be likely to happen to us will be told in the following chapters.

CHAPTER II

THE WATER-RAT

P_{LOP!}
A Water-rat has taken alarm, and has leaped into the brook. A common animal enough, but none the less worthy of notice because it is common. Indeed, it is in many respects a very remarkable creature, and we may think ourselves fortunate that we have the opportunity of studying its habits and structure.

There is much more in the animal than meets the eye, and we cannot examine its life-history without at the same time touching upon that of several other creatures. No science stands alone, neither does any animal, however insignificant it may appear to be; and we shall find that before we have done with the water-rat, we shall have had something to say of comparative anatomy, ornithology, ichthyology, entomology, and botany, besides treating of the connection which exists between man and the lower animals, and the reciprocal influence of civilization and animal life.

In the first place, let us define our animal. What is a water-rat, and where is its place in zoological systems of the present day? Its name in science is *Arvicola amphibius*. This title tells its own story. Though popularly called a rat, the animal has no right to the name, although, like the true rat, it is a rodent,

and much resembles the rat in size and in the length and colour of its fur. The likeness, however, extends no further. The rats are long-nosed and sharp-snouted animals, whereas the water-rat has a short, blunt nose. Then the ears of the rats are large and stand out boldly from the head, while those of the water-rat are small, short, and rounded. Again, the tail of the rat is long and slender, while that of the water-rat is comparatively short. Place the two animals side by side, and you will wonder how any one could mistake the one for the other. The teeth, too, are quite different. Instead of being white, like those of the rat, the incisor teeth are orange-yellow, like those of the beaver. Indeed, the water-rat possesses so many beaver-like characteristics, that it was ranked near the beaver in the systematic lists.

Now, however, the voles, as these creatures ought rightly to be called, are thought to be of sufficient importance to be placed by themselves, and separated from the true beavers. They constitute quite a large group of rodents, including several animals which are popularly ranked among the mice.

One very remarkable characteristic of the voles is the structure of their molar teeth. Being rodents, they can have but two incisor teeth in each jaw, these teeth being rootless, and so set in their sockets that they are incessantly worn away in front, and as incessantly grow from the base, take the curved form of their sockets, and act much like shears which have the inestimable property of self-sharpening when blunted and self-renewal when chipped or actually broken off by coming against any hard substance. Were the teeth to be

without this power, the animal would run a great risk of dying from hunger, the injured tooth not being able either to do its own work or to aid its companion of the opposite jaw. Either tooth alone would be as useless as a single blade of a pair of scissors. There is another notable characteristic of these incisor teeth. If you will examine the incisors of any rodent, whether it be a rat, a mouse, a rabbit, or a beaver, you will see that the tips are 'bevelled' off just like the edge of a chisel. This shape is absolutely necessary to keep the tooth in working order. How is this object to be attained?

In the solution of this problem we may see one of the many links which connect Art and Nature. Should our readers know anything of carpentering, let them examine the structure of their chisels. They are not made wholly of hard steel, as in that case they would be liable to snap, just as does the blade of a foil when undue pressure is brought to bear upon it. Moreover, the operation of sharpening would be extremely difficult. So the blade of the chisel is merely faced with a thin plate of hardened steel, the remainder being of softer material.

Now, it is not at all likely that the unknown inventor of the modern chisel was aware of the analogy between Art and Nature, and he would probably have been very much surprised if any one had stated that he had borrowed his idea from the incisor teeth of the water-rat. Yet he might have done so, for these teeth are almost wholly formed of ordinary tooth matter, and are faced with a thin plate of hard enamel, which exactly corresponds with the hardened steel facing of a chisel.

Any of my readers who possess skates will find, on examination, that the greater part of the blade is, in reality, soft iron, the steel, which comes upon the ice, being scarcely a fifth of an inch in depth. The hardened steel allows the blade to take the necessary edge, while the soft iron preserves the steel from snapping. Should the skate have been neglected, and allowed to become a little rusty, the line of demarcation between the steel and the iron can be distinctly seen. Similarly, in the beaver and the water-rat, the orange-yellow colour of the enamel facing causes it to be easily distinguished from the rest of the tooth. In most of the rodents the enamel is white, and the line of demarcation is scarcely visible.

Now we have to treat of a question of mechanics. If two substances of different degrees of hardness be subjected to the same amount of friction, it follows that the softer will be worn away long before the harder. It is owing to this principle that the edges of the rodent teeth preserve their chisel-like form. Being continually employed in nibbling, the softer backing of the teeth is rapidly worn away, while the hard plate of enamel upon the front of the tooth is but slightly worn, the result being the bevel shape which is so characteristic of these teeth.

As all who have kept rabbits or white mice know, the animals are always engaged in gnawing anything which will yield to their teeth, and unless the edges of their feeding-troughs be protected by metal, will nibble them to pieces in a few days. Indeed, so strong is this instinct that the health of the animals is greatly improved by putting pieces of wood into their

cages, merely for the purpose of allowing them to exercise their chisel-edged teeth. Even when they have nothing to gnaw, the animals will move their jaws incessantly, just as if they were eating, a movement which gave rise to the idea that they chewed the cud.

It is worthy of remark that other animals, which, though not rodents, need to possess chisel-edged incisor teeth, have a similar habit. Such is the hippopotamus, and such is the hyrax, the remarkable rock-haunting animal which in the Authorized Translation of the Scriptures is called the 'coney,' and which in the Revised Version is allowed in the margin to retain its Hebrew name, *shaphan*.

The enamel also has an important part to play in the structure of the molar teeth. Each tooth is surrounded with the enamel plate, which is so intricately folded that the tooth looks as if it were made of a series of enamel triangles, each enclosing the tooth matter. This structure is common to all the members of the group to which the water-rat belongs. It is the more remarkable because we find a somewhat similar structure in the molar teeth of the elephants, which, like the rodents, have the incisor teeth largely developed and widely separated from the molars.

There is nothing in the appearance of the water-rat which gives any indication of its aquatic habits. For example, we naturally expect to find that the feet of swimming animals are webbed. The water-loving capybara of South America, the largest existing rodent, has its hoof-like toes partially united by webs, so that its aquatic habits might easily be inferred, even by

those who were unacquainted with the animal. Even the otter, which propels itself through the water mostly by means of its long and powerful tail, has the feet furnished with webs. So has the aquatic Yapock opossum of Australia, while the feet of the duck-bill are even more boldly webbed than those of the bird from which it takes its popular name. The water-shrews (whom we shall presently meet) are furnished with a fringe of stiff hair round the toes, which answers the same purpose as the web.

But the structure of the water-rat gives no indication of its habits, so that no one who was unacquainted with the animal would even suspect its swimming and diving powers. Watch it as long as you like, and I do not believe that you will see it eating anything of an animal nature. I mention this fact because it is often held up to blame as a mischievous animal, especially deserving the wrath of anglers by devouring the eggs and young of fish.

As is often the case in the life-history of animals as well as of men, the blame is laid on the wrong shoulders. If the destruction of fish be a crime, there are many criminals, the worst and most persistent of which are the fish themselves, which not only eat the eggs and young of other fish, but, Saturn-like, have not the least scruple in devouring their own offspring.

Scarcely less destructive in its own insidious way is the common house-rat, which eats everything which according to our ideas is edible, and a good many which we might think incapable of affording sustenance even to a rat. In the summer-time it often abandons for a

time the house, the farm, the barn, and seeks for a change of diet by the brook. These water-haunting creatures are naturally mistaken for the vegetable-feeding water-vole, and so the latter has to bear the blame of their misdoings.

There are lesser inhabitants of the brook which are injurious both to the eggs and young of fish. Among them are several of the larger water-beetles, some of which are so large and powerful that, when placed in an aquarium with golden carp, they have made havoc among the fish, always attacking them from below. Although they cannot kill and devour the fish at once, they inflict such serious injuries that the creature is sure to die shortly.

I do not mean to assert that the water-vole is never injurious to man. Civilization disturbs for a time the balance of Nature, and when man ploughs or digs the ground which had previously been untouched by plough or spade, and sows the seeds of herbs and cereals in land which has previously produced nothing but wild plants, he must expect that the animals to whom the soil had been hitherto left will fail to understand that they can no more consider themselves as the owners, and will in consequence do some damage to the crops. Moreover, even putting their food aside, their habits often render them obnoxious to civilized man. The mole, for example, useful as it really is in a field, does very great harm in a garden or lawn, although it eats none of the produce.

The water-vole, however, is doubly injurious when the field or garden happens to be near the water-side. It is a mighty burrower, driving its tunnels to great

distances. Sometimes it manages to burrow into a kitchen-garden, and feeds quite impartially on the different crops. It has even been seen to venture to a considerable distance from water, crossing a large field, making its way into a garden, and carrying off several pods of the French bean.

In the winter-time, when other food fails, the water-vole, like the hare and rabbit, will eat turnips, mangold-wurzel, the bark of young trees, and similar food. Its natural food, however, is to be found among the various aquatic plants, as I have often seen, and the harm which it does to crops is so infinitesimally small when compared with the area of cultivated ground, that it is not worthy of notice.

Still, although the harm which it does to civilized man in the aggregate is but small, even its most friendly advocate cannot deny that there are cases where it has been extremely troublesome to the individual cultivator, especially if he be an amateur. There are many hard men of business, who are obliged to spend the greater part of the day in their London offices, and who find their best relaxation in amateur gardening; those who grow vegetables regarding their peas, beans, potatoes, and celery with as much affection as is felt by floriculturists for their roses or tulips.

Nothing is more annoying to such men than to find, when the toils of business are over, and they have settled themselves comfortably into their gardening suits, that some marauder has carried off the very vegetables on which they had prided themselves.

The water-vole has been detected in the act of climbing up a ladder which had been left standing

against a plum-tree, and attacking the fruit. Bunches of grapes on outdoor vines are sometimes nipped off the branches by the teeth of the water-vole, and the animal has been seen to climb beans and peas, split the pods, and devour the contents.

Although not a hibernating animal, it lays up a store of food in the autumn. Mr. Groom Napier has the following description of the contents of a water-rat's storehouse :

'Early in the spring of 1855, I dug out the burrow of a water-vole, and was surprised to find at the further extremity a cavity about a foot in diameter, containing a quantity of fragments of carrots and potatoes, sufficient to fill a peck measure. This was undoubtedly a part of its winter store of provisions. This food had been gathered from a large potato and carrot bed in the vicinity.

'On pointing out my discovery to the owner of the garden, he said that his losses had been very serious that winter, owing to the ravages of these animals, and said that he had brought both dogs and cats down to the stream to hunt for them; but they were too wary to be often caught.'

I do not think that the owner of the garden knew very much about the characters either of the cat or water-vole.

Every one who is practically acquainted with cats knows that it is next to impossible to point out an object to a cat as we can to a dog. She looks at your finger, but can never direct her gaze to the object at which you are pointing. In fact, I believe that pussy's eyes are not made for detecting objects at a distance.

If we throw a piece of biscuit to a dog, and he does not

see where it has fallen, we can direct him by means of voice and finger. But if a piece of meat should fall only a foot or two from a cat, all the pointing in the world will not enable her to discover it, and it is necessary to pick her up and put her nose close to the meat before she can find it.

So, even if a water-vole should be seen by the master, the attention of the cat could not be directed to it, her instinct teaching her to take prey in quite a different manner.

The dogs, supposing that they happened to be of the right breed, would have a better chance of securing the robber, providing that they intercepted its retreat to the water. But if the water-vole should succeed in gaining its burrow or in plunging into the stream, I doubt whether any dog would be able to catch it.

Moreover, the water-vole is so clever in tunnelling, that, when it drives its burrows into cultivated ground, it almost invariably conceals the entrance under a heap of stones, a wood pile, or some similar object.

How it is enabled to direct the course of its burrow we cannot even conjecture, except by attributing the faculty to that 'most excellent gift' which we call by the convenient name of 'instinct.'

Man has no such power, but when he wishes to drive a tunnel in any given direction he is obliged to avail himself of levels, compasses, plumb-lines, and all the paraphernalia of the engineer. Yet, with nothing to direct it except instinct, the water-vole can, though working in darkness, drive its burrow in any direction, and emerge from the ground exactly at the spot which it has selected.

The mole can do the same, and by means equally mysterious.

I may casually mention that the water-vole is one of the aquatic animals which, when zoological knowledge was not so universal as it is at the present day, were reckoned as fish, and might be eaten on fast-days. I believe that in some parts of France this idea still prevails.

With all its wariness, the water-vole is a strangely nervous creature, being for a time almost paralyzed by a sudden shock. This trait of character I discovered quite unexpectedly.

Many, many years ago, when I was a young lad, and consequently of a destructive nature, I possessed a pistol, of which I was rather proud. It certainly was an excellent weapon, and I thought myself tolerably certain of hitting a small apple at twelve yards' distance.

One day, while walking along the bank of the Cherwell River, I saw a water-vole on the opposite bank. The animal was sitting on a small stump close to the water's edge. Having, of course, the pistol with me, and wanting to dissect a water-vole, I proceeded to aim at the animal. This was not so easy as it looked. A water-vole crouching upon a stump presents no point at which to aim, the brown fur of the animal and the brown surface of the old weather-beaten stump seeming to form a single object without any distinct outline; moreover, it is very difficult to calculate distances over water. However, I fired, and missed.

I naturally expected the animal to plunge into the river and escape. To my astonishment, it remained in the same position. Finding that it did not stir, I



Wm. Rogers

The River Cherwell.

reloaded, and again fired and missed. Four times did I fire at that water-vole, and after the last shot the animal slowly crawled off the stump, slid into the river, and made off.

Now in those days revolvers and breechloaders did not exist, so that the process of loading a pistol with ball was rather a long and complicated one.

First, the powder had to be carefully measured from the flask; then a circular patch of greased linen had to be laid on the muzzle of the weapon, and a ball laid on it and hammered into the barrel with a leaden or wooden mallet; then it had to be driven into its place with a ramrod (often requiring the aid of the mallet), and, lastly, there was a new cap to be fitted. Yet although so much time was occupied between the shots, the animal remained as motionless as a stuffed figure.

When I crossed the river and examined the stump, I found all the four bullets close together just below the spot on which the animal had been sitting, and neither of them two inches from its body. Although the balls had missed the water-vole, they must have sharply jarred the stump.

I was afterwards informed that this semi-paralysis from sudden fear is a known characteristic of the animal. It seems to be shared by others of the same genus, as will be seen when we come to treat of the field-mice.

In its mode of eating it much resembles the squirrels, sitting on its haunches and holding the food in its fore-paws, as if they were hands. I am not aware that it ever eats worms or insects, and it may be absolutely acquitted from any imputation of doing harm to any of the fish tribe.

CHAPTER III

THE ENEMIES OF THE WATER-RAT —THE HERON AND THE PIKE

THE water-vole has but few enemies whom it need fear, and one of them is now so scarce that the animal enjoys a practical immunity from it. This is the heron (*Ardea cinerea*), which has suffered great diminution of its numbers since the spread of agriculture.

The Heron, even now, however, when the brook is far away from the habitations of man, may be detected by a sharp eye standing motionless in the stream, and looking out for prey. Being as still as if cut out of stone, neither fish nor water-vole sees it, and if the latter should happen to approach within striking distance, it would be instantly killed by a sharp stroke on the back of the head.

The throat of the heron looks too small to allow the bird to swallow any animal larger than a very small mouse; but it is so dilatable that the largest water-vole can be swallowed with perfect ease.

The bird is not at all fastidious about its food, and will eat fish, frogs, toads, or water-voles with perfect impartiality. It has even been known to devour young water-hens, swimming out to their nest, and snatching

up the unsuspecting brood. In fact, all is fish that comes to its beak.

If the reader should be fortunate enough to espy a heron while watching for prey, let him make the most of the opportunity. Although the heron is a large bird, it is not easily seen. In the first place, there are few birds which present so many different aspects. When it stalks over the ground with erect bearing and alert gestures, it seems as conspicuous a bird as can well be imagined. Still more conspicuous does it appear when flying, the ample wings spread, the head and neck stretched forwards, and the long legs extending backwards by way of balance.

But when it is on the look-out for the easily-startled fish, it must remain absolutely still. So it stands as motionless as a stuffed bird, its long neck sunk and hidden among the feathers of the shoulders, and nothing but the glancing eye denoting that it is alive.

This quiescence must be imitated by the observer, should he wish to watch the proceedings of the bird, as the least movement will startle it. The reason why so many persons fail to observe the habits of animals, and then disbelieve those who have been more successful, is that they have never mastered the key to all observation, *i.e.* refraining from the slightest motion. A movement of the hand or foot, or even a turn of the head, is certain to give alarm; while many creatures are so wary that when watching them it is as well to droop the eyelids as much as possible, and not even to turn the eyes quickly, lest the reflection of the light from their surface should attract the attention of the watchful creature.

One of the worst results of detection is that when any animal is startled it conveys the alarm to all others that happen to be within sight or hearing. It is evident that all animals of the same species have a language of their own which they perfectly understand, though it is not likely that an animal belonging to one species can understand the language of another.

But there seems to be a sort of universal language or *lingua franca* which is common to all the animals, whether they be beasts or birds, and one of the best-known phrases is the cry of alarm, which is understood by all alike.

I need hardly say that it is almost absolutely necessary to be alone, as there is no object in two observers going together unless they can communicate with each other, and there is nothing which is so alarming to the beasts and birds as the sound of the human voice.

Yet there is a mode by which two persons who have learned to act in concert with each other can manage to observe in company. It was shown to me by an old African hunter, when I was staying with him in the New Forest. In the forest, although even the snapping of a dry twig will give the alarm, neither bird nor beast seems to be disturbed by a whistle. We therefore drew up a code of whistles, and practised ourselves thoroughly in them.

Then we went as quietly as we could to the chosen spot, and sat down facing each other, so that no creature could pass behind one of us without being detected by the other. We were both dressed in dark grey, and took the precaution of sitting with our backs against a tree or a bank, or any object which would perform the

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double duty of giving us something to lean against and of breaking the outlines of the human form.

Our whistled code was as low as was possible consistent with being audible, and I do not think that during our many experiments we gave the alarm to a single creature.

When the observer is remaining without movement, scarcely an animal will notice him. I remember that on one occasion my friend and I were sitting opposite each other, one on either side of a narrow forest path. The sun had set, but at that time of the year there is scarcely any real night, and objects could be easily seen in the half light.

Presently a fox came stealthily along the path. Now the cunning of the fox is proverbial, and neither of us thought that he would pass between us without detecting our presence. Yet he did so, passing so close that we could have touched him with a stick.

Shortly afterwards, a cow came along the same path, walking almost as noiselessly as the fox had done. It is a remarkable fact that domesticated animals, when allowed to wander at liberty in the New Forest, soon revert to the habits of their wild ancestors.

As the cow came along the path, neither of us could conjecture the owner of the stealthy footstep. We feared lest it might be that of poachers, in which case things would have gone hard with us, the poachers of the New Forest being a truculent and dangerous set of men, always provided with fire-arms and bludgeons, having scarcely the very slightest regard for the law, and almost out of reach of the police. They would certainly have considered us as spies upon them, and as certainly

would have attacked and half, if not quite, killed us, we being unarmed.

But, to our amusement as well as relief, the step was only that of a solitary cow, the animal lifting each foot high from the ground before she made her step, and putting it down as cautiously as she had raised it.

Then, a barn owl came drifting silently between us, looking in the dusk as large and white as if it had been the snowy owl itself. Yet neither the fox, nor the cow, nor the owl detected us, although passing within a few feet.

In the daytime, the observer, however careful he may be, is always liable to detection by a stray magpie or crow. The bird comes flying along overhead, its keen eyes directed downwards, on the look-out for the eggs of other birds. At first he may not notice the motionless and silent observer, but sooner or later he is sure to do so.

If it were not exasperating to have all one's precautions frustrated, the shriek of terrified astonishment with which the bird announces the unexpected presence of a human being would be exceedingly ludicrous. As it is, a feeling of wrath rather prevails over that of amusement, for at least an hour will elapse before the startled animals will have recovered from the magpie's alarm cry.

Supposing that we are stationed on the banks of the brook on a fine summer evening, while the long twilight endures, and have been fortunate enough to escape the notice of the magpie or other feathered spy, we may have the opportunity of watching the heron capture its prey.

The stroke of the beak is like lightning, and in a

moment the bird is holding a fish transversely in its beak. The long, narrow bill scarcely seems capable of retaining the slippery prey; but if a heron's beak be examined carefully, it will be seen to possess a number of slight serrations upon the edges, which enable it to take a firm grasp of the fish. Very little time is allowed the fish for struggling, for almost as soon as captured it is flung in the air, caught dexterously with its head downwards, and swallowed.

It is astonishing how large a fish will pass down the slender throat of a heron. As has been already mentioned, the water-vole is swallowed without difficulty. Now the water-vole measures between eight and nine inches in length from the nose to the root of the tail, and is a very thickset animal, so that it forms a large and inconvenient morsel.

It is seldom that the heron has, like the kingfisher, to beat its prey against a stone or any hard object before swallowing it, though when it catches a rather large eel it is obliged to avail itself of this device before it can get the wriggling and active fish into a suitable attitude. The eel has the strongest objection to going down the heron's throat, and has no idea of allowing its head to pass into the heron's beak. The eel, therefore, must be rendered insensible before it can be swallowed.

Generally it is enough to carry the refractory prey to the bank, hold it down with the foot, and peck it from one end to the other until it is motionless. Should the eel be too large to be held by the feet, it is rapidly battered against a stone, just as a large snail is treated by a thrush, and so rendered senseless.

If the feet of the heron be examined, a remarkable

comb-like appendage may be seen on the inside of the hinder claw. What may be the precise office of this comb is not satisfactorily decided. Some ornithologists think that it is utilized in preening the plumage. I cannot, however, believe that it performs such an office. I have enjoyed exceptional opportunities for watching the proceedings of the heron when at liberty, as well as in captivity, but never saw it preen its feathers with its foot, nor have I heard of any one who has actually witnessed the proceeding.

It is not always fair to judge from a dead bird what the living bird might have been able to do. But I have tried to comb the plumage of a dead heron with its foot-comb, and have not succeeded.

Another suggestion is that the bird may use it when it holds prey under its feet, as has just been narrated. These suggestions, however, are nothing more than conjectures, but, as they have been the subject of much argument, I have thought it best to mention them.

Sometimes it has happened that the heron has miscalculated its powers, and seized a fish which was too large and powerful to be mastered. Anglers frequently capture fish which bear the marks of the heron's beaks upon their bodies, and in such cases neither the fish nor the heron is any the worse for the struggle.

But when the unmanageable fish has been an eel, the result has, more than once, been disastrous for the bird. In Yarrell's work on the British birds, a case is recorded where a heron and an eel were both found dead, the partially swallowed eel having twisted itself round the neck of the heron in its struggles.



The Heron.

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A very similar incident occurred off the coast of Devonshire, the victim in this case being a cormorant. The bird had attacked a conger-eel, and had struck its hooked upper mandible completely through the lower jaw of the fish, the horny beak having entered under the chin of the eel.

The bird could not shake the fish off its beak, and the result was that both were found lying dead on the shore, the powerful conger-eel having coiled itself round the neck of the cormorant and strangled it. The stuffed skins of the bird and eel may be seen in the Truro Museum, preserved in the position in which they were found.

Having procured a sufficiency of prey, the heron will take flight for its home, which will probably be at a considerable distance from its fishing ground.

Twenty or thirty miles are but an easy journey for the bird, which measures more than five feet across the expanded wings, and yet barely weighs three pounds. Indeed, in proportion to its bulk, it is believed to be the lightest bird known. The Rev. C. A. Johns states



A CORMORANT STRANGLED BY AN EEL.

that he has seen the heron fishing at a spot fully fifty miles from any heronry.

The peculiar flight of the heron is graphically described in a letter published in the *Standard* newspaper, September 25, 1883 :

‘One summer evening I was under a wood by the Exe. The sun had set, and from over the wooded hill above bars of golden and rosy cloud stretched out across the sky. The rooks came slowly home to roost, disappearing over the wood, and at the same time the herons approached in exactly the opposite direction, flying from Devon into Somerset, and starting out to feed as the rooks returned home.

‘The first heron sailed on steadily at a great height, uttering a loud “caak, caak” at intervals. In a few minutes a second followed, and “caak, caak” sounded again over the river valley.

‘The third was flying at a less height, and as he came into sight over the line of the wood he suddenly wheeled round, and, holding his immense wings extended, dived, as a rook will, downwards through the air. He twisted from side to side like anything spun round by the finger and thumb as he came down, rushing through the air head first.

‘The sound of his great vanes pressing and dividing the air was distinctly audible. He looked unable to manage his descent, but at the right moment he recovered his balance, and rose a little up into a tree on the summit, drawing his long legs into the branches behind him.

‘The fourth heron fetched a wide circle, and so descended into the wood. Two more passed on over the valley—altogether six herons in about a quarter of an

hour. They intended, no doubt, to wait in the trees till it was dusky, and then to go down and fish in the river. Herons are here called cranes, and heronries are craneries. (This confusion between the heron and the crane exists in most parts of Ireland.)

‘A determined sportsman who used to eat every heron he could shoot, in revenge for their ravages among the trout, at last became suspicious, and, examining one, found in it the remains of a rat and of a toad, after which he did not eat any more herons. Another sportsman found a heron in the very act of gulping down a good-sized trout, which stuck in the gullet. He shot the heron and got the trout, which was not at all injured, only marked at each side where the beak had cut it. The fish was secured and eaten.’

I can corroborate the accuracy as well as the graphic wording of the above description.

When I was living at Belvedere, in Kent, I used nearly every evening to see herons flying northwards. I think that they were making for the Essex marshes. They always flew at a very great height, and might have escaped observation but for the loud, harsh croak which they uttered at intervals, and which has been so well described by the monosyllable ‘caak.’

As to their mode of settling on a tree, I have often watched the herons of Walton Hall, where they were so tame that they would allow themselves to be approached quite closely. When settling, they lower themselves gently until their feet are upon the branch. They then keep up a slight flapping of the wings until they are fairly settled.

An idea is prevalent in many parts of England that

when the heron sits on its nest its long legs hang down on either side. Nothing can be more absurd. The heron can double up its legs, as is usual among birds, and sits on its nest as easily as if it were a rook or any other short-legged bird.

In many respects the heron much resembles the rook in its manner of nesting. The nest is placed in the topmost branches of a lofty tree, and is little more than a mere platform of small sticks. Being a larger bird than the rook, the heron requires a larger nest, and on an average the diameter of a nest is about three feet.

Like the rook, the heron is gregarious in its nesting, a solitary heron's nest being unknown. In their modes of feeding, however, the two birds utterly differ from each other, the heron seeking its food alone, while the rook feeds in company, always placing a sentinel on some elevated spot for the purpose of giving alarm at the approach of danger.

The heron is curiously fastidious in its choice of a nesting-place, and, like the rook, prefers the neighbourhood of man, knowing instinctively when it will be protected by its human neighbours. Fortunately for the bird, the possession of a heronry is a matter of pride among landowners; so that, even if the owner of a trout-stream happened also to possess a heronry, he would not think of destroying the herons because they ate his trout.

In captivity the heron can be tamed; but it is not to be recommended as a pet. It is apt to bestow all its affections on one individual, and to consider the rest of the human race as enemies, whose eye ought to be pecked out.

I was for some time acquainted with such a bird; but took care to keep well out of reach of its terrible beak, which it would dart to an unexpected distance through the bars of its cage.

It formerly ran loose in a garden, and was almost slavishly affectionate to the gardener, rubbing itself against his legs like a pet cat, and trying in every way to attract his attention. He had even taught it a few simple tricks, and I have seen it take his hat off his head, and then offer it to him.

But just in proportion as it became friendly with the gardener it became cross-grained with the rest of the world, attacking every one who came into the garden, and darting its beak at their eyes. Its last performance caused it to be placed in confinement.

An elderly gentleman had entered the garden on business, when the bird instantly assailed him. Knowing the habits of the heron, he very wisely flung himself on his face, for the purpose of preserving his eyes, and shouted for help.

Meanwhile, the heron, wishing to make the most of its opportunity, mounted upon his prostrate victim, and succeeded in inflicting several severe pecks upon his body and limbs before the gardener could come to the rescue.

The peck of a heron's beak is no trifle, the mandibles being closed, and the blow delivered with the full power of the long neck, so that each blow from the beak is something like the stab of a bayonet; and so strong and sharp is the beak that in some foreign lands it is converted into an effective spear-head.

Few people seem to be aware that a large and

populous heronry exists in Wanstead Park, on the very outskirts of London.

At the end of summer, when the young birds are fledged, the heronry is nearly deserted; but during the early days of spring it is well worth a visit. The great birds are all in full activity, as is demanded by the many wants of the young, and on the ground beneath may be seen fragments of the pale-blue eggs. On an average there are three young ones in each nest, so that the scene is very lively and interesting, until the foliage becomes so thick that it hides the birds and their nests.

We have not yet completed the life-history of the water-vole, which, as I remarked before, involves that of several other creatures.

The Pike, or Jack (*Esox lucius*).—One of the two worst foes of the water-vole has just been described, and we now come to the second. The name, Jack, may perhaps recall to the reader the ancient family of the Lucys, of Charlote Hall, Warwickshire, so mercilessly satirized by Shakespeare. They bore upon their shield the ‘lucy’—*i.e.* the pike; the coat-of-arms being a good example of ‘canting’ heraldry—*i.e.* in which the blazonry of the shield contains a play upon the name of the bearer.

There is no more inveterate foe of the water-vole than the pike. In the stomach of a single pike have been found the remains of three water-voles and some bird, which was probably a duck.

It might be imagined that a pike large enough to swallow a water-vole would not be likely to venture into a brook, and would restrict itself to the river, where it would have plenty of room. But experience has shown

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that a very large pike will sometimes make its way into a very small brook, partly for the sake of food, but sometimes through sheer cunning, in the hope of evading its enemies.

By the time that a pike has attained the weight of twelve or fifteen pounds, he has had to face many and varied dangers, and escape from many foes. While he is young and small his worst foes are those of his own species. Anglers know that there is scarcely any bait so attractive to an old pike as a small pike. All the earlier part of his life is spent in perpetual watchfulness, he having to be always on the look-out for prey by which he can remove his insatiable hunger ; while he has to be equally on guard lest a larger pike should satisfy its hunger with him.

No pike, therefore, can attain to a large size without developing a considerable amount of cunning, and any one who sets himself the task of catching such a fish will find that he must employ all his resources of intellect, aided by experience, before he can delude it even into touching the bait. In spite of its large size, the fish manages to elude observation in a most puzzling manner, and it is no easy matter to make sure of its position. An old fox or an old rat is scarcely more cunning and full of devices than an old pike.

The largest pike that I ever saw at liberty was in a small tributary streamlet of the Cherwell River, near Oxford. A pike of enormous dimensions had for some time been reported as having been seen in various parts of the Cherwell, the general rumours giving its weight as at least thirty pounds. All the anglers of the neighbourhood had tried to capture this mighty prize,

but had failed. Contrary to the habit of most large pike, it did not seem to have established itself in any particular spot, but roamed about from place to place.

Now, the Cherwell itself is but a very small river, so that the locality of a large fish might appear easily discoverable. But it is a very 'weedy' river, and its banks are edged with willows, whose long, red, plume-shaped roots hang into the water from the banks, and form admirable hiding-places for the fish.

One day I was trying my fortune at trolling in the Cherwell, with a six-inch gudgeon for bait, and on coming to a tributary stream, walked along the bank until I could find a spot narrow enough to be jumped.

Coming to a deep-looking pool, I dropped in the bait, by way of not wasting time, and almost immediately felt the bait taken by a pike. Following the golden rule then, and perhaps now, in force among anglers, I sat down on the bank, watch in hand, in order to wait through the weary ten minutes prescribed by custom, and which almost seem to drag themselves out into as many centuries.

Barely half the time had elapsed when a huge head rose to the surface, and the bait was blown out, as it seemed, into the water, the head sinking with a swirl of water where it disappeared. On examining the rejected bait, which had naturally been seized crosswise, I found that it was pierced from head to tail with the teeth of the pike.

I learned that the big fish was afterwards ignominiously taken with a net in one of these tributary brooks, so that its cunning was baffled at last. I also learned that the fish had repeatedly treated other anglers as it

treated me, holding the bait for a short time in its mouth and then rejecting it.

So is it clear that the water-vole will by no means be safe from the pike when it is the inhabitant of the brook instead of the river.

Moreover, it does not need a very large pike to devour a full-grown water-vole. The pike can swallow an animal which seems quite disproportionate to its size. A young pike, barely five inches in length, was seen swimming about with the tail of a gudgeon projecting from its mouth. The gudgeon was quite as long as its captor, and there is no doubt that if the fish had been let alone the pike would soon have digested the gudgeon sufficiently to swallow it entirely.

The late Frank Buckland mentions that a pike weighing eight pounds was caught in the River Itchen. After it was taken out of the water it disgorged a trout of a pound weight. This must have been a sore disappointment for the captor, who would think himself defrauded of a pound weight in his angling record.

The reader will remember that a heron and a cormorant lost their lives by capturing an eel which was too large for them, and it is a remarkable fact that a pike has been known to suffer a similar fate. It can easily be understood that an eel, twisting itself about convulsively in the struggle for life, could coil itself round a bird's neck long enough to cause its death by strangulation; but it seems almost impossible that a pike, being a fish, and therefore breathing by gills, should be suffocated while in the water by an eel.

Yet in the Fisheries Exhibition of 1883 there were two

very remarkable stuffed groups, illustrating the voracity of the pike. In one of them a pike weighing ten pounds had attacked an eel weighing only one pound less. Now, an eel of nine pounds weight is a very large one, lithe, active, and muscular as a snake, and by no means a despicable antagonist. The pike had begun to swallow the eel, but the latter in its struggles forced its way out of the mouth through the gills, and thence into the water beneath the right gill-cover. But it could go no further, the teeth of the pike having almost met through its body.



A PIKE STRANGLED BY AN EEL.

The result was fatal to both. The body of the eel having been forced beneath the gill-cover, the gills could not perform their office, and so the pike was as effectually suffocated for want of breath as were the heron and the cormorant. The dead bodies of the pike and eel were found on the bank of the River Bure in October, 1882.

The second group consisted of a pike and a duck. The pike had attacked the duck as the bird was diving, and had tried to swallow it. It succeeded in getting the head,

neck, and part of the breast down its throat; but the duck, in its struggles for life, had naturally spread its wings. These formed an insurmountable obstacle to the fish, and the result was that the duck was drowned and the pike suffocated, both having died for lack of respiration.

So the 'plop' of the water-vole into the brook from the bank has not been to us the mere splash of a frightened animal into the stream. It has opened for us many trains of thought, and taken us into several sciences. It has shown us something of the links which connect it with man, birds, and fishes, and so has led us into ornithology and ichthyology. It has shown how the inventions of man have their prototypes in the animal kingdom. Comparative anatomy and physiology have also been shown to form portions of the life-history of the familiar animal, and have demonstrated the truth of the axiom enunciated on page 8, that no animal and no branch of science can stand alone.

CHAPTER IV

THE FIELD-VOLE AND THE BANK-VOLE

LIKE other beings, the water-vole has its relatives, two of whom will come within the range of our subject. Being small creatures, they go by the popular name of mice, just as their larger relative is popularly called a rat. These are the field-vole and the bank-vole, both of which we may expect to find on the banks of our brook, especially when the banks are clothed with shrubs. The former of these animals is a very old acquaintance of mine, and when I was a lad I could go into a field and make almost certain of catching a field-vole (*Arvicola agrestis*) within about ten minutes.

The Field-vole.—This little animal looks very much like a water-vole seen through the wrong end of an opera-glass, except that the fur is redder and the ears are longer in proportion to the size of the head. The tail is only about one-third as long as the body—a peculiarity which has earned for it the popular name of ‘short-tailed field-mouse.’ A more appropriate name for it is ‘campagnol.’

Even in this country the campagnol is apt to be one of the worst foes of the agriculturist, especially at harvest and seed time. Not only does it devour the ripe corn in



Field Voles.



Two Food-storing Species of Voles.

the field, but it makes its way into ricks and barns, and eats large quantities of the gathered corn. Moreover, just after the seed-corn has been sown it digs the grains out of the ground, thus doing mischief which is often attributed to the sparrows and other small birds. In France, however, where not a kestrel, or, indeed, any unprotected bird, can be seen, the campagnol can carry out its depredations without hindrance, and consequently increases until it becomes an actual plague. In the Department of Aisne alone, a few years ago, the fields were honeycombed with the burrows of the animal, and the farmers spent some seventy thousand pounds in ridding their fields of the nuisance. First poison was laid down; but so many hares and rabbits were killed that another plan had to be tried. Stacks of hay and straw were then made, containing quantities of poisoned carrots, turnips, and beetroot. The agriculturists, therefore, had to pay heavily for doing that which the kestrel would have done in a great degree, if they had suffered it to live and carry out its appointed work in preserving the balance of Nature.

The owls, again, are determined enemies of the campagnol, more than half the food on which they and their young live being composed of these mischievous little animals. Fortunately for the owls, their nocturnal habits save them from the destruction which would have befallen them had they sought their food in the light of day.

If we wish to see this pretty little creature, we have only to watch carefully the field through which our brook runs, and we shall be almost certain to find it. But we must know where to look and how to look.

The favourite locality of the campagnol has already been mentioned; but the detection of the little animal requires some practice. A novice in the art may traverse a low-lying field, and hunt along the banks of the brook from daybreak to dewy eve, and never catch a glimpse of a campagnol. Another will go into the same field, and in a quarter of an hour will produce several specimens.

Those who wish to catch it must know its ways. It is not of the least use to hunt up and down the field in chase of the campagnol, and those who wish to see it must reverse the old aphorism about Mahomet and the mountain. They cannot go to the campagnol, for it will keep out of their way; but if they wait patiently, the campagnol will come to them.

The secret for catching the campagnol is as follows:

Go into any field which is bounded by a brook, and lie down, taking care that the sun faces you; otherwise your shadow will be thrown on the grass, rendering the detection of the animal extremely difficult.

When you have arranged yourself in an easy posture, keep your eyes on the ground, and try to look between the green blades, so as to see the colour of the soil. On a first trial you may probably wait until your patience is exhausted, and yet see nothing. But do not be disheartened, and try again, as nothing but practice will give the needful skill.

Only a small portion of ground can come under your observation as you recline on your arm, and a few minutes ought to make you acquainted with the colour of every inch of the soil. Presently you will become aware that a little patch of soil is redder than it was a minute or

two ago. Bring your free hand down smartly on the spot, and you will find a campagnol in your grasp.

Immediately afterwards, you will find that the campagnol has teeth, and knows how to use them. But if you understand the animal's ways, you will seize it without danger of being bitten, just as if you know the nettle's ways you can grasp it without danger of being stung.

Like its larger relative, the campagnol, when suddenly startled, loses its presence of mind, and remains for a moment or two without motion. During that moment of consternation, shift your grasp so that the body of the animal rests in the palm of the hand, while the finger and thumb seize the sides of the head, so that the creature cannot turn its head to bite. The knack is soon learned, though perhaps at the expense of a bite or two, and the shifting of the grasp becomes instinctive.

Want of practice soon causes the eyes to become slow to detect the creature, which steals so silently among the grass-blades, and the ready knack of the fingers is equally apt to fail just when it is wanted. However, a little practice soon restores the keenness of sight and deftness of touch, and in a short time the campagnol will be unable to pass under the observer's eyes without detection, or to escape the grasp of his fingers without capture.

So stealthily does the campagnol glide among the grass stems that the field may be swarming with them, and yet their presence will not even be suspected by man. This fact brings us to another illustration of the assertion that the life-history of one animal always involves that of others.

The Kestrel.—The natural food of the kestrel (*Tinnunculus alaudarius*) largely consists of the cam-pagnol, so that where the one is seen the other will probably be at no great distance. High in air the kestrel hovers with quivering wings, its bright eyes directed downwards, and scanning the field below. Suddenly it drops down to the ground, rises with something in its claws, and flies away. It has seen and caught a field-vole, and is carrying it home to its young. From its custom of balancing itself in the air with its head to the wind, it is often known by the name of 'windhover.'

With what astonishing sight must not the kestrel be gifted to perform such a feat! It is difficult enough for a human being to watch a square yard of ground so carefully that a field-vole shall be seen as it glides among the grass. How wonderful, therefore, must be the powers of vision which enable the bird to watch a large field, to detect from that height the little dusky animal, and pounce down upon it with unerring swoop!

How astonishing must be the optical mechanism of those eyes which at so great a distance from the prey can act like telescopes, and yet can alter their range so rapidly that in the few seconds which are consumed in making the stoop, they have accommodated themselves to an entirely different focus!

In his *At Last*, C. Kingsley mentions that in passing through a tropical forest the traveller is frequently checked by some creeper which hangs in the path, and which is not seen because the eye cannot focus itself with sufficient rapidity. Yet the traveller is only proceeding at a walking pace, whereas the stoop of the kestrel on its prey is swift as the fall of a stone through

THE FIELD-VOLE AND THE KESTREL 43

the air, and in a second or two the eye has to accommodate itself from a range of many yards to that of a few inches.

The value of the kestrel in keeping down the numbers of the field-vole, and so aiding in preserving the balance of Nature, can hardly be over-estimated. There have been cases where the field-voles had increased to such a degree that pitfalls had to be dug for their capture, and they had to be destroyed artificially, because the kestrels and other predaceous birds and animals had been almost extirpated.

Other enemies to agriculture are also destroyed by the kestrel. Mr. Johns mentions an instance where the stomach of a kestrel was opened, and was found to contain, beside a field-vole, nearly eighty caterpillars, twenty-four beetles, and a leech!

Now we will return to our field-vole. Like the squirrel and several other rodents, it makes two nests, one for the winter and the other for the summer. The winter nest is mostly made at some distance from water, is formed at the end of a burrow, and seldom reaches more than a few inches below the surface of the ground. It is to this winter nest that the poet Burns refers in his exquisite stanzas addressed to a mouse whose nest had been destroyed by his ploughshare, and beginning,

‘Wee, sleekit, cow’rin’, tim’rous beastie.’

Such, indeed, is the fate of many a winter nest. Supposing, however, that the creature should be snapped up by the kestrel while out in search of food, the nest will be deserted; but it will not be wasted. There are

always beings who are glad to find a ready-made burrow which will save them the trouble of excavating one for themselves. Among them are several species of wasp and humble-bee, most of whose nests are made in the deserted burrow of the campagnol.

Here, again, is an example of the manner in which the life-histories of dissimilar animals are linked together. Few persons would think that there could be any connection between the wasp and the kestrel, and yet our walk along the banks of our brook has shown us that such is the case, and that the connecting link is the campagnol.

Like the water-vole, the campagnol lays up a store of winter provisions, not in its living-room, but in a chamber excavated for the purpose. The treasure-house sometimes contains a very miscellaneous store, the fruit of the hawthorn and the wild rose being the staple.

Cherry-stones mostly form a large proportion of the stores, as many as three hundred having been found in a single chamber. The mode in which the campagnol obtains the cherry-stones would hardly be suspected except by those who are in the habit of watching the varied phases of animal life.

The chief purveyors of cherry-stones are the black-bird and the thrush. Both these birds are exceedingly destructive among the cherry crops, as I know from personal experience. My study overlooks a number of fine cherry-trees, one of them being so close to the house that by leaning out of the window I can touch the fruit with an ordinary walking-stick. As soon as the fruit ripens the thrush and the blackbird hold

high festival, eating the cherries from the branches and feeding their young with the ripe fruit.

It is really amusing to watch the proceedings of the birds, especially the unmerciful manner in which the young birds peck their parents when they consider that they are not fed fast enough. Neither young nor parent is in the least afraid of me as I sit at the open window, so that I can see every movement.

Sometimes the entire cherry is pulled off the branch, but when the fruit is very ripe the soft portion only is eaten, the stone still being left attached to the stalk. In either case, the stone will be sure, sooner or later, to fall to the ground, whence it is picked up by the campagnol and added to its store for the coming winter.

Here, again, is a link connecting together the life-histories of the blackbird, thrush, and campagnol. Furthermore, it affords an example of the care that is taken that nothing on the earth shall be wasted. Whenever a living creature has no further use for anything which once was connected with its life-history, there is sure to be some other animal which wants it and is waiting for it.

We have already seen how the abandoned winter nest of the campagnol is utilised by the wasp or humble-bee, and we now see that when the blackbird and thrush have abandoned the cherry-stones as useless to them, there is the campagnol waiting for them, and ready to carry them off to the store-chamber which it has previously prepared.

Besides the winter nest, there is the summer nest, which is primarily intended for the reception and nurture

of the young. This, like the corresponding nest of the squirrel, is made of slight materials and loose structure, so that the air is freely admitted. It is generally composed of grass blades, which have been torn in strips by the campagnol. It is globular in shape, and



NEST OF THE CAMPAGNOL.

is mostly placed on the ground, amid concealing grass or herbage.

There is, however, before me a photograph of the nest of a campagnol, which was discovered in a very remarkable position, and made of very unusual materials. It was found in a garden store-house at Castle Carey, by the Rev. W. Smith-Tomkins, Vicar of Durstow. He

kindly sent me a copy of the photograph, together with the following description—

‘BEDFORD VILLA, THE SHRUBBERY,
‘WESTON-SUPER-MARE,
‘August 8, 1886.

‘This nest of the short-tailed field-mouse was found by me a few years ago on a heap of barley straw, which was used to cover a small store of potatoes. Its chief interest to the finder, in addition to its beauty, consists in this. It was all manufactured out of one kind of raw material—namely, the leaves of the barley straw, which the maker shred up into thin threads according to her taste, so as to suit the different parts of the structure. There was no other material available for use.

‘The mouse had found its way into the store-house through a hole under the wall. I am sorry to say that she was killed when found, and before the nest had been used for its proper purpose. Two or three weeks before I had looked over the place, and she had not commenced operations.

‘On referring to *Homes without Hands*, I find it stated by Mr. J. J. Briggs that he could never find an entrance to the interior (the nests being closed up, as you say is the case with the nest of the harvest mouse). I infer from this, that it is due to its incompleteness that the entrance in this case is open and visible, and that its structure is therefore so open to inspection.’

With the description and photograph Mr. Tomkins sent a few portions of the nest, some of the barley leaves being of their original width, and others split up into

fibres as fine as ordinary sewing cotton. In a subsequent letter he states that the hole through which the campagnol made her entrance into the house opened into the stable yard of a neighbour.

Its mode of eating the provisions which it stores is rather remarkable. It would naturally be supposed that, as other animals (including man) do, it would eat the thick, soft, and sweet exterior of the 'hip' or fruit of the wild rose, and reject the hard, small seeds, with their fluffy envelope. But it does just the contrary, eating the seeds and rejecting the exterior.

When in America, in 1884, I saw a flock of pine grosbeaks busily feeding upon the berries of the mountain ash at Worcester. Very pretty they looked, the rosy plumage of the two or three males contrasting boldly with the dark, sombre green of the many females. I should not have noticed them but for their mode of feeding.

It was at the beginning of February—the very depth of a New England winter. I had to make my way up a rather steep hill, and over paths which, by reason of constant traffic over snow, were as slippery as ice. Many persons are in the habit of scattering sand or pulverised brick on the paths, and seeing, as I fondly thought, a few yards of the latter material, I gladly made my way towards it. To my disappointment—on that ground at least—I found that the red material was not brick, but the soft external part of the mountain ash berry, the birds only eating the seeds, and allowing the rest of the fruit to fall to the ground.

Then, the campagnol has a remarkable way of eating the cherry-stones. When the squirrel eats a

nut, it nibbles off a little piece of the sharp end, inserts the edges of its incisor teeth, wedge fashion, and splits the nut in two. The campagnol begins like the squirrel, but when it has bitten off the end of the cherry-stone, it does not split the shell asunder, but in some way of its own contrives to get the kernel out.

The Bank-vole (*Arvicola glareolus*), as might be expected from its name, is to be sought upon the banks of our brook. As its tail is nearly as long as that of the common mouse, it is often called the 'long-tailed field-mouse,' and it may easily be distinguished from a true mouse which does inhabit the country by the shortness of its ears, the bluntness of its snout, and the white colour of its paws.

It has many of the habits of the campagnol, but its diet is more diversified, including insects, worms, and snails; and it is accused of eating young birds.

A rather startling incident, showing its fondness for sweet things, was witnessed by my son, Theodore Wood, some years ago. In those days he was an enthusiastic lepidopterist, and was in the habit of going out at night 'treacling' for moths. This process is simple in principle, though rather difficult in practice. Many moths are irresistibly attracted by the odour of treacle mixed with the newest and coarsest rum. The moth-hunter, therefore, mixes treacle and rum, and at night paints with the mixture the trunks of suitable trees. Attracted by the odour, the moths fly to the bait, swallow the sweet mixture greedily, and become so intoxicated that they either fall or can be picked off the tree with the fingers.

Now, the 'treacler' has many enemies. Slugs of

the most portentous dimensions descend from their hiding-places in the tree, and absorb the treacle, just as if they were so many hungry leeches fastening on a plump and thin-skinned patient. Toads sit in a row round the trunk of the tree, waiting to snap up any moth that falls. The bats soon learn the value of a treacled tree, and sweep rapidly by it, whipping off the preoccupied moths as they pass by.

On one occasion my son caught sight of a bank-vole, which had climbed up the tree and was taking its share of the treacle.

All the voles are admirable climbers, as indeed is necessary, in order to enable them to gather the corn and fruit of the hawthorn and wild rose. Their paws grasp the corn-stems or tree-twigs as if they were hands, like those of the monkey, and they run about the slender branches of the hedges and shrubs that line the banks like monkeys among the trees of their native forests.

Like the campagnol, they make globular nests of grass, which may be found among the herbage of the bank by those who know where and how to look for them.

CHAPTER V

THE WATER-SHREWS

JUST as the ordinary farmer lumps together half a dozen species or so of small birds under the comprehensive title of 'sparrows,' so do most people consider that every animal which labours under the misfortune of being small in dimensions, brown in colour, and having a tail appended to its body, must be either a rat or a mouse, according to its size.

Water-shrews.—No one can be familiar with the banks of any brook without being acquainted with these pretty little creatures, which, like their relatives of the land, are almost invariably considered as mice, although, as we shall presently see, they are not connected in any way with the creatures which they superficially resemble.

If the observer will pick out some spot where he can be tolerably screened, and where the water of the brook is clear and rather shallow, he will be very likely to come upon the water-shrew (*Cróssopus fódiens*). Both of these names are very appropriate. The first, or generic, name is of Greek origin (as all generic names ought to be), and signifies 'fringe-footed.' The name is due to the fringe of stiff hairs with which the feet are edged. A similar fringe is found on the

lower surface of the tail. As these fringes are white, they are very conspicuous. Their object will presently be seen.

The second, or specific, title is (as all specific titles ought to be) derived from the Latin, and refers to the habits of the species. It signifies a digger or burrower, and alludes to its custom of digging burrows in the banks of the brook in which it loves to disport itself, and where it obtains much of its food.

As with other creatures, absolute stillness and silence are required on the part of the observer before the water-shrew will even show itself. Though there may be plenty of the little animals within a few yards, not one will be visible. But in ten minutes or thereabouts the silence will reassure them, and they will make their appearance on the bank.

I have seen them playing with each other on the bank of a rivulet which at that time was so dried up by want of rain that the water was scarcely a foot in width. They were almost within reach of my hand, and I could easily have killed one or two with a stick. But as I prefer watching the habits of animals to killing them, they continued their pretty and graceful evolutions undisturbed.

Being sociable little creatures, a single water-shrew is seldom seen, and, if the observer should detect one of the animals, he may be tolerably certain that it will presently be joined by others. They are as playful as kittens, and, in their way, quite as graceful, their lithe bodies and active limbs being able to assume as many varied attitudes as may be seen in a family of kittens at play.



Water-shrews.

They chase each other over the bank, and pretend to fight fiercely, squeaking the while as if wounded to death, just as puppies will do when playing and making believe to be hurt. Then one will jump into the water and dive, as if to escape, while one or two others will pop in after it, and chase it under water.

Indeed, on the occasion which I have just mentioned the whole proceedings reminded me forcibly of the games in which the boy swimmers of Oxford were wont to indulge for the best part of a summer's day. One of our favourite games was for one to dive into the Cherwell (mostly from the top of a pollard willow), and then for the rest to dive after him, and try to catch him under water before he had swum a certain distance. We used to shriek in our sport quite as much, and as loudly in proportion to our size, as the water-shrew squeaks; and I cannot but think that if any being as much superior to man as man is to the shrew could have watched us, we should have amused him much in the same way that the shrew amuses us.

In his admirable work on the British mammals, Mr. Bell states that the water-shrew will dive into a shallow, rippling stream, and run over the stones, pushing its long snout under them and turning them over, should they be small, for the sake of dislodging and capturing the fresh-water shrimp (*Gammarus*), and then carrying it off to the bank and eating it with an audible, crunching sound. I have not personally observed the creature engaged in this sub-aquatic hunt, though I have often seen it dive, and have been near

enough to note its singularly beautiful aspect as it wriggles its irregular way under the surface.

Air is largely entangled among the hairs of its body, the imprisoned bubbles looking just like globules of shining silver. The water-spider, which is also a common though unsuspected inmate of the brook, is adorned in a similar manner when it dives. No one can watch these pretty little creatures without being interested and amused. But amusement ought not to be our sole object in observing the inhabitants of a brook. Let us catch one of the animals, and keep it long enough to examine it. There is little difficulty in catching a water-shrew, as the little animals are so fearless when they think themselves unobserved that a small hand-net can easily be slipped over them in their gambols. We need not keep our captive long, and, after inspecting the characteristic fringe of the feet and tail, we will examine its head and jaws.

A mere glance at the head ought to tell us that it cannot be a mouse, no mouse having a long, pointed snout, which projects far beyond the lower jaw. On opening its mouth and examining its teeth, we not only see that it cannot be a mouse, but that it is not even a rodent. It is, in fact, much more nearly related to the hedgehog than to the mouse. All its teeth are sharply pointed, and the lower incisors project almost horizontally forward. The animal must, therefore, be predaceous in character; and a comparison with the structure of other animals shows that it belongs to the important though not very numerous group of the insectivora, or insect-eaters, of which the mole is the generally accepted type. There are, however, some

systematic zoologists who hold that the shrews, and not the moles, ought to be the typical representatives of the insectivora. This, however, is a matter of opinion, and its discussion does not come within the scope of our present undertaking.

Before we release our captive, we will examine its ears. These are small, as are those of all water-frequenting mammals, but there is a peculiarity in their structure which is worthy of notice. They are furnished with three small valves, which, being made on the same principle as those of the heart, are closed by the pressure of the water as soon as the animal dives below the surface, and open by their own elasticity when it emerges.

Now, we will allow it to escape into the water, and take note of it as it swims away. I have already casually referred to the irregular course which it pursues in swimming. This is due to the fact that the water-shrew drives itself along by alternate strokes with the fringed hind feet, so that its progress reminds the observer of that of a boat propelled by two unskilful rowers, who have not learned to keep time. Still, its pace is tolerably rapid, though it lacks the steady directness which characterises that of the water-vole.

Another remarkable point in its swimming is that the outstretched legs cause the skin of the flanks to be widened and flattened in a way that reminds the observer of the flying squirrel when passing through the air. Although in the water-shrew the skin is not nearly as much flattened as in the squirrel, it is expanded sufficiently to alter the shape of the creature in a notable manner.

Supposing the observer to be tolerably familiar with the terrestrial shrews, he must have been struck by the blackness of the fur of the back, and the contrasting whiteness of the under surface. So strongly, indeed, is the contrast marked, that an exceptionally dark variety was long considered as a distinct species, and called the 'oared shrew.'

Like the insectivora in general, the water-shrew is not at all particular in its diet, providing it be of an animal nature. As most of us know, the hedgehog, although its normal food consists of insects, snails, and the like, will feed on frogs, toads, mice, and even snakes and blindworms. So will the water-shrew, if it be fortunate enough to find the dead bodies of any of these creatures, for it is not sufficiently powerful to kill them for itself.

In Mr. Bell's work, to which reference has already been made, there is an interesting notice of the carnivorous habits of the water-shrew. An ordinary rat had been caught and killed in a steel trap, and upon the body of the rat was perched a little black creature, which proved on examination to be a water-shrew, which was trying to make a meal upon the rat. It had already bored a hole in the side of the rat, and was so absorbed in its task that it suffered itself to be touched with a stick without being alarmed.

This little animal does not restrict itself to the neighbourhood of water, but is often found some distance inland. It has been accused, and I believe with justice, of devouring the eggs of river fish, a crime which, as I have already mentioned, is wrongly attributed to the water-vole.

Although we may see the water-shrew swim away and disappear below the surface of the water, we may watch in vain for its reappearance. As is done by the duckbill of Australia, the animal always makes several entrances to its burrow, one of them being on the side of the bank, below the surface of the water. It can, therefore, enter or leave the brook without being observed.

All the shrews, whether of the land or water, were at one time the objects of universal dread, and even the toad and blindworm could scarcely be more feared. As one old writer remarks, in his sweeping condemnation of the animal, 'It beareth a cruel minde, desiring to hurt anything, neither is there any creature that it loveth, or it loveth him, because it is feared of all.'

It was held to be the special foe of cattle, biting their hoofs while in the stall, and running over their bodies as they lay chewing the cud in the field. A cow over which a shrew had run was said to be 'shrew-struck,' and to fall straightway into a sort of consumption, accompanied with swellings of the skin.

The disease, being caused by the shrew, could only be cured by the shrew, the usual mode of treatment being to burn the animal alive and rub the cow with the ashes. As, however, a shrew might not always be at hand when a cow is taken ill, the ingenuity of our forefathers devised a plan of having essence of shrew always within reach.

A shrew was caught alive, and a hole bored into the trunk of an ash tree. The shrew, which must be still living, was put into the hole, the entrance to which was then closed with a wooden plug. As the body of the shrew decayed, its virtues were supposed to be absorbed

into the tree, so that a branch of a 'shrew ash,' or even a few leaves, were supposed to be an effectual cure, if laid upon the suffering animal.

The tail of a shrew, when burned and powdered, was considered as a certain remedy for the bite of a dog; only the tail must be cut from a living shrew.

The Shrew, or Shrew-mouse (*Sorex vulgáris*).—I have made casual mention of the shrews of the land. Two species of land-shrews are recognised as inhabitants of England. One is the common shrew, or shrew-mouse, which for a long time was thought to be identical with the water-shrew. The fringed feet and tail, however, afford sufficient indications that it is a distinct species.

Towards the end of autumn there seems to be quite a mortality among the shrews, their bodies being plentifully strewn about the roadways and paths across fields. Why this should be so no one can tell, though many conjectures have been offered, one absurd theory being that man and the shrew are so antagonistic to each other, that when a shrew tries to cross a pathway made and used by man it dies from sheer antipathy.

This fact was known to Pliny, and Topsel, the old writer who has already been quoted, is of opinion that when a shrew dies in a cart-rut the finder should not fail to secure so valuable a prize.

'The shrew which by falling by chance into a cart road or track doth die upon the same, being burned and afterwards beaten or dissolved into dust, and mingled with goose-grease, being rubbed or anointed upon those who are troubled with the swelling coming by the cause of some inflammation, doth bring into them a wonderful and most admirable cure and remedy.'

The same author mentions its predaceous habits, and states that it is especially fond of the putrid flesh of the raven, the French using it as a bait, and killing numbers of shrews as they are feasting on the dead bird. He is especially careful to mention that the deluded shrews are killed with shovels.

The Pigmy-shrew (*Sorex pygmæus*) is the third species of British shrew. It is even smaller than the harvest mouse, and is the smallest of all the British mammals.

I have mentioned the three species, because until quite recently much confusion reigned concerning them and their habits, and much difficulty has been found in disentangling them. For example, no distinction had been recognised between the common shrew and the water-shrew, while the pigmy-shrew was thought to be the young of the common or erd-shrew, and an exceptionally large specimen of the water-shrew was supposed to be a separate species, and distinguished by the name of oared-shrew.

So, by means of carrying out our study of the water-shrew we have not only found much that is interesting and amusing, but have added something to our knowledge of animal physiology.

CHAPTER VI

THE KINGFISHER

MY previous remarks on the life-history of the campagnol show how one creature is dependent upon another, and how, when the habitation of the campagnol is abandoned by its excavator, a tenant is sure to be found as soon as the dwelling is vacated.

Such is also the case with the burrow of the water-vole, should the animal fall a victim to the pike or heron, and a more fitting or picturesque tenant cannot be found than the Kingfisher, a bird which is far more plentiful than is generally suspected.

The Kingfisher (*Alcédo hispida*).—It may seem somewhat strange that the most brilliantly coloured of our British birds should be able to pass its life and rear its young in the vicinity of human habitations, and yet that its existence should be unknown to the resident population. Yet I have seen this to be the case, even the country people who lived within a few hundred yards of a kingfisher's nest hardly being able to believe their eyes when I showed them a handful of the eggs.

To the frequenter of the brook and its banks hardly any sight is more familiar than that which is so admirably described by Faber in his poem *The Cherwell*:



The Kingfisher.

There came
Swift as a meteor's shining flame,
A kingfisher from out the brake,
And almost seemed to leave a wake
Of brilliant hues behind.

As the bird darts along its horizontal course just above the surface of the water, its flight is so swift that it looks just as if a blue streak had been drawn through the air.

Fortunately for us, the kingfisher is one of the few brightly-coloured birds which lose none of their brilliance in flight. Those who have watched the humming-birds when darting through the air with speed even more rapid than that of the kingfisher, or hovering before some flower into which they are plunging their long tongues, say that they give scarcely any indications of their gem-like plumage, but look as sombre of hue as the brown humming-bird moth, which is so plentiful in the autumn.

But the kingfisher looks, when on the wing, as bright as, or, if anything, even brighter than, it does when at rest. Possessed though it may be of the most vivid blues, greens, red, and white, these colours are so artistically blended that even those who know the bird intimately can seldom state the exact colouring of each part, but are obliged to give a general idea of it, and say that it is green above and red below.

I know the bird well enough, and have more than once described its colours; but even now I should not choose to write the details of its hues without reference to the bird itself, or some description which had been written by a competent observer.

No one afflicted in the least degree with colour-blindness, a malady which is far more common than is

generally supposed (as is shown by the reports of examinations in colour which have to be passed by candidates for the army, navy, and appointments on the railways), would make anything of the description of a kingfisher.

Without going into needlessly minute details, we may say that the head and back of the neck are deep green, relieved by a number of blue spots upon the tips of the feathers. The shoulders are dark green, and the rest of the back is verditer-green, the tail being dark blue. The wings are coloured like the head. When the bird is darting along on its arrowy flight, the eye cannot separate these colours, and, brilliant as is the tinted streak when the sun is shining, it is impossible to say whether the hue be green or blue.)

If we turn the bird over, and examine the under surface, we shall see that the throat is nearly white, and the remainder is ruddy chestnut. There is also a conspicuous white streak passing from the eyes to the back of the neck.

Though these colours are so remarkably arranged, the general effect is that of bluish-green upon the back and red below; and it is very strange to find so many people who must have seen the bird make the most extraordinary mistakes when they mention its colour. No one would expect that Mary Howitt, for example, who is essentially a poet of the country, would have written of the 'scarlet plume' of the kingfisher. I fancy that at the time she must have been thinking of the woodpecker.

Now let us try to watch the kingfisher as we have watched the water-vole, the campagnol, and the water-shrew. There is not the least difficulty in doing so, as the kingfisher is, when understood, a bird which has but

little fear of man, and, indeed, seems to prefer the neighbourhood of human habitations.

I have seen it darting over the surface of the water in the desolate 'creeks' of the mouth of the Medway, and rather wondered to see it so far from human habitations. But I afterwards learnt that upon some of the many islands which are formed by these creeks, and which, from the level of the water, appear to be totally deserted, there is a series of small settlements, only approachable by boats at high water, on account of the deep mud which surrounds their banks.

If, while sitting quietly on the bank of our brook, we catch a glimpse of the blue-green flash of a kingfisher's back, and will remain where we are without moving, we shall be tolerably certain to see the bird again, and probably be able to track it to its nest, or at all events to its favourite fishing spot.

As its name implies, the bird lives almost entirely on fish, which it catches in a very ingenious manner. Selecting some object which overhangs the water, it takes its perch upon it, and with its big beak sunken on its breast awaits the approach of its prey. Suddenly, it may be seen to drop from the perch into the water, and to emerge with a fish in its beak. Returning to the perch, it bangs the fish against it, throws it up in the air, catches it with its head downwards, and swallows it.

When any one sees for the first time the kingfisher catching its prey, and has taken his ideas on the subject from illustrated books, he is always surprised at the manner in which the bird catches the fish. Artists invariably represent the kingfisher as darting at its prey with its head downwards, just as if it were a diver taking

a 'header' into the water. Whereas the bird simply lets itself drop into the water. Then there is a great splashing, and presently the bird emerges with its prey. It always has some favourite perch, so that when it is once seen in the act of fishing, it may be watched whenever the observer can spare an hour.

It might be imagined that, on account of its brilliant hues, the kingfisher must be very conspicuous on its fishing perch. This, however, is not the case. I have often passed a place where the bird was sitting, and have been startled by its sudden rising. Brilliant as it may be, it is singularly inconspicuous. Though the statement may seem a paradox, all practical lepidopterists know that there is nothing so difficult of detection as a white moth on a black fence, and *vice versa*, and perhaps, on the same principle, the brilliant colours of the kingfisher are a safeguard to the bird.

I have already stated that just as a thrush has a favourite stone on which to break the shells of his snails, so the kingfisher always has his favourite perch from which he watches for the fish first, and against which he can bang them into insensibility when caught. Seated on this perch, he really seems to feel that he is 'monarch of all he surveys.' Another passage from Faber's poem (containing a playful allusion to the bird's name) may be appropriately quoted here :

Thou hast a fair dominion here, Sir King,
And yon tall stone beneath the alder stem
Seems a meet throne for a gay-crowned thing
That wears so well its tawny diadem.

It is to be wished that all poets had been equally observant, for they really seem to vie with each other in

depicting the bird in so absurd a fashion that no one could recognise it.

Perhaps we need not be very much surprised when Cowper (essentially the poet of the town) describes the kingfisher as catching its prey in the ocean, or when Savage, another poet of the town, ranks the kingfisher among the songsters ; but it is more than startling when Shelley, of all poets, represents himself as having seen two kingfishers clinging with their backs downwards to a branch, and *feeding upon its berries!*

Poetry and fact are as much at variance with each other regarding the nesting of the bird. Many of my readers will remember the graceful legend of Alcyonë, the daughter of Neptune and wife of Ceyx, who for love of her drowned husband plunged into the sea, and was changed into a kingfisher, together with him. Since that time, the kingfisher has always lived near water, and always with a single mate.

Around this legend many others were accreted, especially as regards the manner in which the bird makes its nest and rears its young. It was thought to build on the sea-shore a very light and fragile nest, which, when finished, was launched upon the waves. As so fragile a structure would be shattered to pieces by the slightest storm, it was thought that from seven days before the winter solstice to seven days after it the weather was perfectly calm. This period was known by the name of 'halcyon days,' a term which is frequently used by those who have no idea of its derivation.

When the bird had hatched its young and abandoned its nest, the mysterious nest itself (which from the description was evidently the empty shell of the sea

urchin, surrounded with its multitudinous spines) was considered a very valuable medicine.

Those of my readers who would care to follow out the subject will find much quaint and interesting information in Pliny's *Natural History*, Book x., and in Ovid's *Metamorphoses*, Book ii. *Ceyx et Alcyone in Aves*.

The real nesting-place of the kingfisher is in a singularly prosaic locality, namely, in a hole in the ground, mostly, but not always, in the bank of the brook. Still more prosaically, the kingfisher will always, if possible, take advantage, as I have already mentioned, of the deserted hole of a water-rat, so as to save itself the trouble of burrowing.

Within this burrow, and at no great distance from its mouth, the nest of the kingfisher is made. The material is supplied by the bird itself, being nothing but the bones of the fish which it has eaten, and which have been ejected, as is the custom with predaceous birds. These bones are arranged into a circular shape, and upon them the eggs are laid. I have seen an assertion to the effect that the object of this bony platform—for it scarcely deserves the name of nest—is to keep the eggs from being swamped, in case the river should rise after heavy rain. But, as the thickness of the nest is seldom more than an inch, and often much less, it could be no protection to the eggs in case of a flood, which might raise the level of the water several feet. It is simply intended as a platform on which the eggs and newly hatched young may be kept from contact with the cold ground.

Those who care for making collections of birds' eggs always consider that a kingfisher's nest is a prize. The bird is wonderfully prolific, hatching seven or eight

young, and being capable of furnishing twice that number of eggs, if they be taken a few at a time. The colour of the eggs is almost invariably said to be glossy white. So it is in a cabinet, but not in the nest. When newly laid, the eggs are of a delicate pinky hue, the yelk being partly perceptible through the diaphanous shell. But when the eggs are 'hard set' they are whitish-grey, and when 'blown' for the cabinet they become white, like notepaper. I have, however, contrived a plan by which the lovely translucent pinkness can be perfectly restored. Here is the plan.

First, empty and thoroughly wash out the interior, not by a hole at each end—a practice which destroys the exquisite contour of the egg—but through a single hole in the middle of one side. This is very easily done. Get a piece of common glass tube from a chemist, about sixteen or eighteen inches in length. About three inches from one end hold it in the flame of a spirit lamp, if you have one, or, if not, in the flame of a gas burner. You must bring it very gradually to the flame, or it will break. When it is red-hot, draw your hands apart steadily and rather slowly, and you will be able to draw out the tube in two pieces, each with a pointed end. Take the longer of the pieces, and break off the point at any spot which will leave an aperture sufficiently large to admit an ordinary darning needle. This we will call the 'washing tube.'

Now make in one side of the egg a hole just large enough to admit the point of the washing tube easily. For this purpose there is nothing like a sailmaker's needle, which is triangular, and can be used as a drill by being twirled between the finger and thumb.

Next, with a long darning needle (which is easier of management if the eye end be thrust into the handle of a camel's hair brush) break up the yelk entirely, and stir it up with the white. Now suck some water into the washing tube, introduce the end a very little way into the egg and blow the water into the egg. This must be done very gently and steadily, and by degrees the entire contents will be washed out by the same hole. Put the egg aside until it is thoroughly dry, which will not be the case for several days.

Now take some white wax, melt it, and mix it very thoroughly with powdered lake or carmine. It should be several shades darker than the intended colour of the egg, as the shell will lessen the depth of hue. When it is well mixed, heat it nearly to boiling point, and heat also the egg and a washing tube. Now draw up some of the hot wax into the tube, and blow it into the egg. A very little wax—say the third of a saltspoonful—will be amply sufficient for one egg.

Next hold the egg over the spirit lamp or gas, or before a fire, and keep turning it between the fingers until the coloured wax is equally distributed over the inner surface of the egg. When you see that all streakiness has disappeared, withdraw it very carefully from the heat, and allow it to cool, taking care to keep turning it until the wax has set.

The effect is magical. The opaque, dead whiteness, which was as the pallor of a corpse compared with the glowing tints of the living being, will have disappeared, and in its place will be found the original pinkness, restored as it was before the egg was emptied of its coloured contents.

The same process will restore the colour of the eggs of the swallow tribe, wrens, etc., the ground hue being naturally a delicate pink, which degenerates into dead white when the eggs are emptied.

Now, if the reader should wish to prepare an object which will be an ornament to any museum, he can do as the late Mr. J. Gould did many years ago, and procure a perfect nest of the kingfisher, with the eggs. Here is the plan which he employed, and which the reader can adopt.

By means of a stick measure the distance of the nest from the entrance of the burrow, and then cut down carefully upon it from above. Should there be any portion of a nest in the hole, remove it, so as to force the bird to begin afresh. Replace the sod carefully, and take precautions that it shall not be broken in by any one inadvertently treading on the spot.

Watch the burrow, so as to be quite sure that the birds are still at work, and wait for at least three weeks. Then take with you an abundant supply of cotton wool, a small dark-coloured plate, and an ordinary butcher's knife, such as can be bought for sixpence. Now with the stick fill the whole of the burrow with cotton wool, and then remove the sod above the nest. When Mr. Gould did so, he found that he had secured the parent bird, as well as the eggs and nest. By means of the knife scrape away the earth under the nest, and gradually insert the plate. With judicious handling you will then have been able to remove the nest uninjured. Empty the eggs, and line them with coloured wax, as has already been described, replace them on (for we can hardly say in) the nest, cover them with a suitable

glass, and you will have an object of much beauty and surpassing interest. It will be as well to place the eggs very carefully on their sides, so that the single hole through which they were 'blown' shall not be visible, and also to fasten them to each other with a tiny drop of diamond cement or gum tragacanth, so that they shall not be shaken apart by any casual jar.

The chief obstacle to success lies in one word—Boys.

Should the nest be made in any bank to which boys can have access, your operations cannot escape their prying eyes, and, even though they gain nothing, they will take a mischievous delight in thwarting you. So, unless the brook should run through your own grounds or through those of a friend, I do not recommend the attempt to procure a perfect nest of the kingfisher.

Now for a word as to the nature of the hole in which the kingfisher makes its simple nest. Some observers have said that the bird always employs the deserted burrow of the water-rat, while others are as positive that it always makes its own burrow, one writer stating that he has watched the kingfisher for thirty years, and has 'never seen an instance of its taking up with the abode of its most deadly enemy, the water-rat.'

As is often the case in Natural History, the kingfisher here plays the part of the shield with the gold and silver sides. The bird can and does make its own burrow, but it also does avail itself of the deserted burrow of the water-rat. Why the water-vole, which, as we have already seen, feeds on vegetable substances, and has been execrated by the river-side agriculturist for robbing his stores of beets, turnips, beans, grapes, etc., should be

termed the most deadly enemy of the kingfisher, is more than I can understand.

Here again is an example of the wonderful manner in which the life-history of one animal is linked with that of another. We have seen how the swoop of the kestrel upon the field-mouse gives a home to the humble-bee, and we now see how the stroke of the heron's beak upon the water-rat's head assists the kingfisher in preparing a dwelling-place for her young.

It is scarcely necessary to mention that the material of the nest must necessarily depend upon the nature of the food. Although a bird which inhabits the bank of an inland brook will find an abundant supply of fish, and therefore will form its nest wholly of their bones, another bird, which lives under different conditions, is obliged to accommodate itself to them. Thus, when the kingfisher inhabits the banks of tidal rivers, the 'shells' of shrimps are found to be mixed with the fish-bones. I have no doubt that if we were to open the burrows of the kingfishers which I have so often seen among the creeks of the Medway, we should find that the nest was constructed almost entirely of the remains of shrimps and other small crustacea.

We have not yet quite finished with the kingfisher, concerning which there still survives a superstition quite as remarkable as that which once existed respecting the 'halcyon days' and the wave-born nest. When the bird is killed and stuffed, its skin is supposed to possess the power of denoting the direction of the wind. I have several times seen in rustic cottages the stuffed skin of a kingfisher suspended from a rafter by a thread fastened to the point of its beak, and, on inquiry as to its object,

have been told that the breast always pointed in the direction of the wind.

Some centuries ago a similar custom prevailed, except that the bird was stuffed with extended wings, and suspended by the middle of its back. Its beak was then supposed to point to the wind. Dryden, for example, alludes to this superstition in *The Hind and the Panther*.

And here his corpse, unblessed, is hanging still,
To show the change of winds with his prophetic bill.

Many such passages might be quoted; but I will content myself with one from Shakespeare. In *King Lear* time-servers are described as men who

Turn their halcyon beaks
With every gale and vary of their masters.

The kingfisher is one of the birds which, as far as is known, sings only upon the wing. Perhaps some of us might not be likely to call the sharp, quick cry of the bird by the name of song. But we must not judge other creatures by ourselves, and the short scream of the flying kingfisher may be as sweet a melody to its mate within her burrow as is the song of the soaring skylark to his spouse upon her nest amid the grass.

I have never been fortunate enough to see the brood of young kingfishers sitting near the nest, and hungrily piping for their food. But those who have done so have always been delighted with the sight, and I only hope that my readers may watch the kingfisher in its haunts with better success in this respect than has hitherto fallen to my lot.

I cannot take leave of the kingfisher without an

allusion to the diminution of its numbers, which is caused by the fashion of using the stuffed skin as an article of feminine adornment.

The humming-birds suffer greatly from the demand for their skins. I have before me a figure drawn from the specification of a fashionable milliner for a lady's evening dress. It is trimmed with long rows of stuffed humming-birds, and there are even several humming-birds on her fan. This is bad enough. But the skins are those of the male birds only, the females being too dull in colour to be used as ornaments. Consequently, none of the skins are those of mother birds, whose young are left to die of hunger. But as the plumage of the female kingfisher is quite as beautiful as that of her mate, a kingfisher's skin on a lady's dress, or in her hat, may well be the representative of seven or eight young birds which have been starved to death.

CHAPTER VII

THE WATER-OUSEL AND THE FRESH- WATER SHRIMP

NOT very far from the Shrivenham Station, in Wiltshire, there is a tiny brooklet, or, as Burns would call it, a 'burnie,' on the banks of which I have many a time watched the water-rat, the wagtails, the kingfisher, and the graceful antics of the water-shrew.

Though small, and sometimes, after a prolonged drought, reduced in places to less than a yard in width, it never is quite dried up, as is the case with more pretentious streams at no great distance. In one place it runs under a road which skirts the lower portion of a hill, and then plunges down some five feet, so as to form a waterfall on a small scale. Then it rushes down a steep incline over stones of considerable size, and after twenty yards or so makes another plunge of two feet or so, and then flows on tranquilly over comparatively level ground. Ivy and moss grow profusely along the banks, almost concealing the first of the two waterfalls. It was a singularly picturesque spot, and I made a very rough and, unfortunately, hasty sketch of it, which is now before me.

We called the place by a variety of names. The more

classical among us called it *Bandusia*, in allusion to Horace's exquisite and untranslatable ode. It is true that no ilex was there, nor even holly, though there were oaks, which might take its place. There were plenty of the 'hollowed stones.'

— unde loquaces.

Lymphæ desiliunt tuæ.

Some, in whom the niceties of the Latin tongue were imperfectly developed, called it by the name of *Hedera-dash*, an expressive though hybrid term.

Then, the two little waterfalls were dignified, in allusion to the Nile, with the name of the First and Second Cataracts. However, the name of *Hedera-dash*, like the equally hybrid but convenient word 'bicycle,' prevailed above the others, *Bandusia* falling into undeserved disuse; while the first and second cataracts were seldom named, the single word *Hedera-dash* being used collectively for the whole of the spot as far as the smooth water.

One afternoon, while feeling under the ivy fringe that shaded the first cataract, I came on a soft, rounded cushion of peculiarly smooth moss, and presently discovered a small round hole in it. On inserting my finger, a bird suddenly dashed out into my face, startling me exceedingly, and almost making me lose my footing. There could be but one bird which would make such a nest in such a situation, and I knew, without needing to see it, that I had accidentally discovered the nest of **The Water-Ousel or Dipper** (*Cinclus aquaticus*).

In accordance with the usual custom of the dipper, the bird had covered its domed nest with fine moss, and

had arranged its position so that it should be always wet with the spray of the waterfall, and should be kept as fresh and green as if it had originally grown there. The nest of the dipper, indeed, really seems as if it had inspired the poet with the familiar words :

Here, in cool grot and mossy cell,
We rural fays and fairies dwell.

In the nest were several white eggs, of which we took one or two, leaving one as a nest egg, which would encourage the mother bird to complete her full number of five before she began to sit.

I afterwards found another dipper's nest near the Swindon Reservoir, but at a much greater distance from the water than is usually the case with the nest of this bird. Let those who are fortunate enough to meet with a dipper watch it carefully. It cannot well be mistaken for any other bird, looking, as it does, very much like a thrush without its tail. As it finds its food chiefly in swiftly rippling brooks, it mostly inhabits the more northern parts of England and Scotland, where the country is hilly, and consequently the brooks run swiftly over their stony bed.

It is not an easy bird to watch, its sober plumage of brown above and white below rendering it peculiarly inconspicuous. Moreover, it has a way of slipping into the water in a quiet fashion, and when there behaves in a manner entirely different from that of the kingfisher. The latter bird watches for a fish from above, 'flops' into the water, and immediately returns to its perch, being in the water only a few seconds, and never chasing its prey below the surface ; whereas the dipper prefers



The Water-ousel.

to run or jump into the water, forcing itself below the surface, and working its way up the stream by the united use of its feet and wings, its plumage being studded with little air-bubbles, like those of the water-shrew and water-spider. As it goes along, it searches diligently for small aquatic insects and molluscs, turning over the smaller stones, so as to dislodge any living creatures that may be hiding under them. Among the animals which constitute its rather miscellaneous diet are water-snails, small fish, and especially the many species of beetles that inhabit the water either in their perfect or larval states. The bird also seizes upon the 'caddis worms' which crawl on the bed of the stream, but in order to get at the white grubs it is obliged to carry the caddis together with its case to shore, and then to pull the tough case to pieces.

The Fresh-water Shrimp (*Gammarus pulex*) is a staple article of the dipper's diet. It is not a very distant relative of the sand-hopper, whose lively gambols on the seashore are so familiar to all who have walked along the sands at the edge of the receding tide.

It is sometimes called the fresh-water screw, because when taken out of the water and laid on the ground it cannot leap like the sand-hopper, or even crawl on its legs. All it can do is to lie on its side, and kick itself round and round, leaving a corkscrew-like line of water on the ground. Several allied species are common on the seashore, and when laid on the sand trace similar patterns on it, instead of jumping about and then burrowing under the sand, as is done by the sand-hopper. The fresh-water shrimp is one of the inhabitants of the brook whose very existence is often

unsuspected, although there is scarcely a square foot of the brook's bed which does not contain one or more of these interesting crustacea.

The fresh-water shrimp has a singular mode of obtaining its food. It wriggles its way under stones, searching about until it is assured that no more food is to be obtained. Then it emerges from beneath the stone, and allows itself to be carried for a foot or two



THE FRESH-WATER SHRIMP.

down the stream. Then it arrests its progress, and with a peculiar jerking movement forces its way up the stream again until it has found another stone under which it may renew its search for food.

Just above Erith there is a little stream which once had a place in history. Springing from a 'holy well' at Lessness Heath, it ran swiftly down the spur of Shooter's Hill at the extremity of which is situated Erith Church, and then spread and deepened until

it formed the Eare-Hythe, or Old Harbour, in which the celebrated 'Great Harry' used to lie at anchor.

It is now narrowed to a tiny brooklet, which crosses a footpath between Erith and Belvedere. A small bridge is now built over it, but for some years after I came to live in the neighbourhood it was only crossed by a single plank, not more than a few inches above the surface of the water. Hundreds of pedestrians crossed the brook daily, and yet I never spoke to one who had noticed that the fresh-water shrimp absolutely swarmed in the shallow, rippling brooklet over which he had been accustomed to pass for years.

The dipper has often been denounced as feeding on the eggs of trout, salmon, and other valuable river fishes, and, in consequence, it is placed on the list of the many creatures which the gamekeeper classes under the very comprehensive title of 'vermin,' and shoots whenever he sees them.

This is especially the case in Scotland, where the salmon is jealously protected. But, although many of these birds have been dissected during the spawning season, nothing has been found in their digestive system except insects, molluscs, and fresh-water shrimps.

In Scotland the dipper is one of the commonest birds that can be found in the neighbourhood of water. It goes by various names, one being the water-crow, or sometimes the water-pyet, while in many places it is actually known as the kingfisher! The dipper is notable for being one of the few birds whose appearance belies their character. There is literally nothing in its general appearance, or in any detail of its external or internal

structure, which gives the least indication of its aquatic habits.

When a bird seeks for its food beneath the surface of the water, we naturally expect that its feet will be webbed, and the plumage close and compact, like that of ducks, geese, penguins, and other diving birds. Yet there is nothing either in the feet or feathers to distinguish the dipper from any of the land-frequenting thrushes.

Apparent anomalies of a similar kind are to be found both in the animal and vegetable kingdoms, as we shall see in the course of this work. I may, however, mention here that the common cormorant affords an example of an anomaly of an opposite kind. The webbed feet of the water birds are especially made for propelling their owners through the water, and are little suited for locomotion on land, while they seem to be utterly unfit for perching on branches. But, although the cormorant has webbed feet, and is as awkward a walker as any duck, goose, or swan, it yet has the power of perching on branches ; a remarkable fact, which has been noticed by Pliny, and has been introduced into *Paradise Lost* by Milton. Describing Satan's entrance into Eden, the poet has the following passage :

Thence up he flew, and on the tree of Life,
The middle tree, and highest that there grew,
Sat like a cormorant ; yet no true life
Thereby regained, but sat, devising death.

Another remarkable point about the dipper is that it is a singing bird—the only instance, as far as I know, of an aquatic bird possessing the power of song. Though

tolerably familiar with the dipper, I have never been fortunate enough to hear it sing. Its notes are not loud, but are bright and lively, and are mostly to be heard in the early morning. It sings when perched, mostly choosing a stone near the water, and accompanying the song with various lively gestures.

CHAPTER VIII

THE DABCHICK, THE WATER-HEN, THE COOT, AND THE WATER-RAIL

SHOULD the reader be investigating one of the stilly flowing brooks about the beginning of spring, and take up his post of observation near any part where it widens into a sort of pool, is edged with reeds or bulrushes, and is sheltered by overhanging branches, he will probably see one of the most entertaining birds that are to be found in the water.

The Little Grebe, more popularly called the Dabchick (*Pódiceps minor*), is the bird he will see. Formerly it was known by the appropriate and expressive name of Didapper, *i.e.* Divedapper, a title which is used by Shakespeare:

Like a didapper peering through a wave,
Who, being looked on, ducks as quickly in.

Pope also mentions the bird, but in terms so absurdly at issue with its habits, that I fancy he derived all his knowledge of it from the passage which has just been quoted. Even though he did live on the banks of the Thames, he could never have seen the bird, or he would not have written such lines as these :

As when a dabchick waddles through the copse,
On feet and wings, and flies, and wades, and hops.



Punting.

Pope, however, was a Londoner pure and simple, and had no eyes but for the inhabitants of streets. The bird is by no means easy of approach, and those who are able to watch it must have made much progress in the arts of silent approach and motionless observation, as already described. Supposing the reader to have gained such a post as has been mentioned, and to be silently scanning the dark pool, suddenly there pops up like a cork a little dark bird, which restlessly paddles hither and thither with a quick, jerky movement, and as suddenly vanishes, like a coin from a juggler's hand. After a long interval, up it pops again, swims about for a short time, and again dives, not even raising a splash.

So instantaneously can it dive, and so keen is its eyesight, that Captain Mayne Reid mentions that when as a boy he was shooting dabchicks with an old-fashioned flint-gun, it was necessary to mask the pan with a piece of paper (much to the detriment of the aim), the bird diving at the flash, and being safely under water before the shot could reach it.

When below the surface it swims, or rather flies, with astonishing velocity, the wings being used as much as the feet, just as I have seen the guillemots act when under water. The bird is much more at home in the water than on land, and if it did find itself in a copse, might perhaps waddle in its attempts to reach the water wherein would be its true refuge; but its legs are much too short for wading, and it can no more hop than a sparrow can dive. Pope seems to have been taken by the sound of the name, to have known that the bird had something to do with water, and then to have evolved the dabchick out of its inner consciousness.

The feet of the dabchick, as is the case with all the grebes, afford a remarkable compromise between the feet of the terrestrial and aquatic birds. In most of the water birds all the toes are joined by a broad web, as in the familiar examples of ducks and geese. But in the grebes each toe is separate, three of them having a web at each side, so as to give to the toe the appearance of a leaf.

I have mentioned the spring as being the best time of year for watching the dabchick. This is because at the approach of summer it mostly leaves the brook, and takes to rivers, lakes, and similar waters, where it can hardly be seen at all, except with the aid of a glass, and where its movements beneath the surface are wholly out of ken.

On the banks of such waters the dabchick makes its nest, so that the wanderer by the brook will have little if any chance of seeing it. Even if he should visit the lake or river, he would not be likely to recognise the nest, even if he should see it, for it does not look like a nest. To all appearance it is nothing but a dirty heap of half-decaying reeds, loosely tumbled together, as if left by the retiring waters after a flood. So exact is the resemblance, that even experienced ornithologists have been deceived by it, and have passed by the nest without suspecting its real character.

The fact is, that the unsightly looking and unpleasantly smelling heap is not the nest at all. The real nest lies beneath the reeds, which are intentionally placed there by the bird for the purpose of hiding the eggs. They have a singular effect on the eggs which they conceal.

When first laid the eggs are pure white, but in a very short time they become stained by the damp reeds which

are laid over them, and darken into brown, mottled more or less with yellow. A newly laid egg of the dabchick which still retains its whiteness is extremely rare, inasmuch as no process at present known can discharge the stains and restore the egg to its original colour.

It has been thought by some ornithologists that the dabchick does not sit upon her eggs, but merely covers them so as to hide them, and then leaves them to be hatched by the joint influences of the sun's rays and the heat evolved from the decaying reeds.

This theory is, however, contradicted by those who are intimately acquainted with the bird, and who say that it is sufficiently wary to detect a foe at least half a mile away, so that the two birds would have plenty of time to cover their nest with the reeds which were already prepared, and then to slip away silently through the water, after their wont. Perhaps some of my readers may be enabled to settle this disputed question.

Like many other birds, the dabchick has two different suits of clothes, one for the summer and the other for the winter, the former being much the handsomer of the two.

The Water-Hen is another aquatic bird which does not betray in its structure any indication of its mode of life. In the same still, reed-fringed portions of slowly flowing brooks which shelter the dabchick, the water-hen or moor-hen (*Gallinula chloropus*) may almost certainly be seen. Like that bird, it prefers wider waters, such as rivers and lakes, for nesting purposes, the brook scarcely affording sufficient shelter; but at other times of the year the brook affords such abundant stores of food that the bird abandons the river and returns to the brook.

Watching the water-hen is a very different business from surprising the dabchick in its haunts, as the bird is not nearly so suspicious; neither does it possess the astonishing powers of diving that distinguish the dabchick. Still, it is a wary bird, and affords good practice to the lover of Nature in watching animal life without alarming the creature that is under investigation. When, however, its wiles, of which it has not many, are learned, it is easily watched by those who will take a little trouble. In the Isis, Cherwell, and their many tributary brooks, the water-hen abounds, and as most of my boyhood and early manhood was passed in Oxford, I had many opportunities of tracing the life-history of the bird.

Like many other creatures, the water-hen knows instinctively when it is detected. When its sharp ears are alarmed by an unguarded footstep, or, still worse, by the voice of an intruder upon its haunts, its first idea is to slip aside unseen. So it paddles silently to the nearest bank, glides under the shadow of the overhanging foliage, where its dark plumage can hardly be distinguished, and steals off until it thinks itself in safety.

Sometimes, when the cover is insufficient for this manœuvre, it dives to some distance, always making for some floating foliage or growing water plant, and then rising very gently under the shelter of the leaves, only permitting its beak to appear above the surface, so as to allow it to breathe. In order to retain itself securely in this position, and yet to avoid betraying its locality by the slightest movement, it grasps with its long toes the stems of the water plants, and so is able to baffle the keenest eye.

A trained water dog may detect it and drive it from its refuge, but I presume that our object is to watch the bird, and not to frighten it, and we shall attain our purpose by patient waiting. If, when the water-hen dives, we do not stir, but content ourselves with keeping a close watch on the surrounding objects, we shall presently be rewarded by seeing it rise slowly and cautiously to the surface, glancing suspiciously in all directions, and then, having assured itself that no foe is near, it will swim about as freely as ever.

Should an intruder come suddenly on the bird while it is swimming, it seldom dives, but darts off horizontally on the wing, flying with unexpected speed just above the surface, and mostly allowing its feet to trail in the water. A most startling effect is produced by this sudden flight, and more than once I have seen gunners so disconcerted by the bird starting up under their eyes that they have allowed it to get out of shot before they have recovered from their surprise.

Like the kingfisher, the water-hen lays seven or eight eggs, but takes so little trouble to conceal them that I really wonder how the bird continues to maintain its place in the country. For nesting purposes it seldom remains near the brook, but betakes itself to rivers, and preferably to lakes or very large ponds well fringed with vegetation. Still, I have found many of the nests on the banks of the swiftly flowing River Dove, so beloved by trout-fishers, and so celebrated for its frequent mention in Walton's *Angler*.

As to the nest, it hardly deserves the name, being nothing more than a quantity of sticks, reeds, and leaves put together without the least attempt at art. In, or

rather on, this nest, which is little more than a platform with a slight hollow in it, the bird lays a great number of eggs, yellowish brown in colour, and spotted slightly with reddish brown. Six or seven is the usual number, but I have more than once taken eight eggs from a single nest. The bird always has two broods in one year, and sometimes brings up a third, if the weather be propitious—a fact which may account for its numbers.

When the young are hatched, they are quaint little beings, looking like round balls of dark down rather than birds. As soon as they leave the egg-shell, they tumble themselves into the water, and are at once as much at home as if they had been swimming for years.

Sometimes the nest is made too far from the water for the newly hatched young to reach it. They can swim well enough when once in the water, but their limbs are not as yet capable of bearing them over land. The long toes of the parent are now used for a new purpose, the bird picking up its feeble offspring with them and carrying them to the water. She will sometimes even carry her eggs in the same manner. The bird has been seen in the act of carrying two young at the same time, one grasped in each foot.

She is rather capricious as a nest-builder, and, like the wren, will occasionally make more than one nest before she is satisfied. Even after the nest has been completed, and some of the eggs laid, she has been known to build another nest at some distance, and then transfer the eggs with her feet.

After heavy and continuous rain, the rivers are apt to rise so high that the nest would be swamped and the eggs destroyed. The water-hen, however, has an

instinctive prevision of a flood, and increases the thickness of the nest, so as to keep the eggs out of the water. The same remarkable instinct has been noticed in the swan. While engaged in the task of adding to the nest, the birds divide the task between them, one remaining by the nest and acting as architect, while the other brings materials.

The all-useful toes of the bird serve yet another purpose. Though so good a swimmer and diver, the water-hen does not possess webbed feet. The extremely long toes, however, afford so much resistance to the water that the web would only add to the weight of the feet, without sensibly increasing their swimming powers.

Though so wary a bird, the water-hen, like many other creatures, soon finds out its friends, and will voluntarily seek the habitations of man. Some years ago, one of my friends had a house in Sussex, the garden running down to the edge of a brook. Poultry of various kind were kept there, and among them was a pair of water-hens, which came to be fed as regularly as any of the inhabitants of the poultry yard. They began by striking up an acquaintance with the ducks in the water, and then by degrees accompanied them on land. I have seen them running about on the lawn in front of the house as much at their ease as any of the other birds.

The Coot.—There are two other aquatic birds which are often confounded with the water-hen. One of these is the coot (*Fúlica atra*), which in size, shape, and general habits resembles the water-hen almost as much as the crow resembles the rook.

Strange to say, the characteristic by which the birds

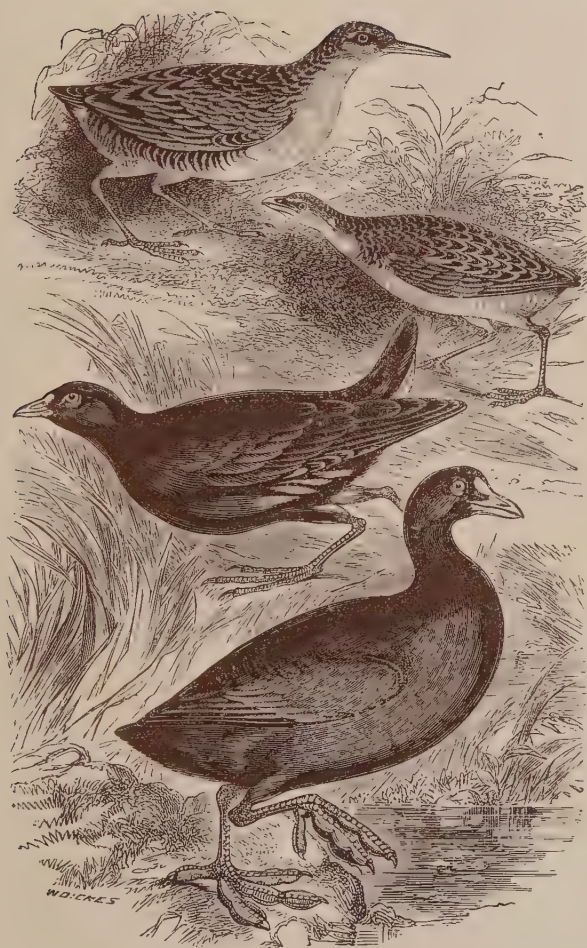
can be distinguished is the same in both cases—namely, the colour of the base of the beak. In the water-hen there is a large dark red patch at the base of the beak, while in the coot the corresponding patch is white, and very conspicuous, especially if the sun be shining on the bird, just as the white base of the beak distinguishes the rook.

The coot is not so often seen in brooks as the water-hen, and I do not know of any instance of its nesting in such a locality. Moreover, the water-hen remains in the same locality throughout the year, while the coot is one of the partially migrating birds, haunting the brooks, rivers, and lakes during the warm weather, but betaking itself to the mouths of tidal rivers as soon as the cold weather comes on, knowing instinctively that it will find plenty of food among the young flat-fish, shrimps, and other inhabitants of estuaries.

As to the nest of the coot, though I have examined many of them, I never found one which could be approached without wading or the assistance of a boat. I have tried both plans, and prefer the boat.

No one who studies even a tiny brook must be averse to wading when occasion demands, but the wading which is required in reaching a coot's nest is of the most unpleasant character. The nest is always placed at some distance from the shore, and is mostly based on a foundation of growing reeds or sedges. I have found many of them on small tussocks just rising out of the water, crowned with rushes, and surrounded by sedge.

Now, the bed of the large and shallow pond where the nests are placed is necessarily of a muddy nature, and wading through mud is by no means an agreeable process.



The Water-rail.

The Common Gallinule.

The Corncrake.

The Common Coot.

Mud is always slippery, and always studded with bits of sticks, stones, the shells of fresh-water mussels, water-snails, etc., etc., on which it is not pleasant to tread with bare feet.

Then, you never know from one step what is likely to happen at the next step. You may come upon a patch of comparatively firm ground, or you may slide down into a hole a couple of feet in depth, in which latter case you will to a certainty measure your length in the water, either on your face or on your back, as the case may be, and you will find no slight difficulty in getting up again.

If you take a boat, a punt is the best for the purpose. It only draws an inch or two of water, a valuable property in the shallow waters which the coot frequents, and it is so heavy that its weight will force a path through the sedges, which when growing thickly form a wonderfully strong barrier. I have more than once vainly attempted to drive a skiff through a sedge bank. The sedges seem at first to yield, but they suddenly recoil, and then drive the boat back again, in a most exasperating manner.

The nest of the coot is very similar in appearance to that of the water-hen, but is of rather stronger make. It is simply laid on the reeds or sedges, and is not attached to them in any way, so that if the water should suddenly rise, the nest floats away with the birds still sitting on it.

In the defence of its nest the coot displays great courage, as is shown by Mr. Alex. Duncan in the *Naturalist's World*, of October, 1884.

‘On February 27, this year, a pair of coots in-

habiting the rushes at our garden foot laid the foundation of their nest. They kept building it for a day or two, when I noticed one morning that the nest had disappeared. Not knowing what had occurred, I imagined that the birds had sunk it, so as to form a strong foundation on which to build the superstructure. On the morning following that on which the nest had disappeared, a new foundation or layer of reeds was laid on the top of the old one, and the birds were busy during the whole of that day in enlarging and adding to the layer. Visiting the spot again the next morning, I saw that the nest had again disappeared, and that the birds, especially the male, were in a high state of excitement.

‘They did not attempt to build any more on the old site, but began in another place, and I was surprised to see that the first bundle of reeds which they placed in position shared the same fate as those of the first nest. But next day the riddle was solved in an amusing way—to me at least, but not to the subjects of the joke.

‘Standing on the newly laid down reeds was one of the tame swans kept for the ornamentation of the lock, and seemingly coolly choosing the site of the coot’s nest for its own occupation. It was bending down and breaking off all the reeds within its reach, and laying them crosswise, evidently just commencing to build its own nest. Of course this was the reason of the coot’s nest disappearing so often, as the weight of so large a bird as a swan was more than sufficient to sink it out of sight.

‘But the best part of the affair is yet to come. The coots all the while had been rushing about very excitedly in an aimless way, seemingly not knowing what to do. However, things had evidently come to a climax, for one

of them, mounting the swan's back with a rush, began a most furious pecking and pulling about its upper regions, while its mate boldly charged it up in front in good style, forcing the swan to cease its labours and defend itself. This it could not do very well, hampered as it was by the surrounding reeds, and by the dexterity of its small and nimble antagonists. It is needless to say that the coots came off victorious, driving the large enemy ignominiously away—minus its dignity and a lot of feathers, which latter floated in the air like smoke after a battle—for a coot, when aroused, will fight with great pertinacity. The male of the pair I am writing about is a noted warrior in the tribe, thoroughly punishing all that venture near its chosen domain or mate.

‘They were never molested again by the swans, one lesson being enough. But I am sorry to say that the nest, when it contained three eggs, was rifled, and the coots began and finished another nest in deeper water, where it was secure from the egg-hunter, and where they successfully reared their brood.’

I have already mentioned that when the two birds are swimming, the white patch on the base of the beak is a distinguishing mark of the coot. When they are on land they can be easily distinguished by means of the legs. The feet of the coot are grey, with a tinge of green, while those of the water-hen are dark olive-green, gaining for the bird its specific name of *chlóropus*, or green-footed. Then the coot has part of the lower leg orange-yellow, while the corresponding portion of the water-hen is scarlet.

Even the shape of the foot differs. The toes of the coot are shorter than those of the water-hen, and are

slightly fringed with web on the sides, while those of the water-hen are entirely without web.

The Water-rail (*Rallus aquaticus*) is the last of three similar aquatic birds, and, like its first cousin, the corn-crake, is tolerably plentiful, but seldom seen.

Like that bird, it has an invincible repugnance to using its wings, and even when tracked by dogs can hardly be induced to take to the air. It winds in and out of the foliage just as the corncrake does among the stems of corn, and when at last compelled to take flight, it only rises just high enough to clear the bushes, and flies quickly and horizontally with dangling legs, just as has been mentioned of the water-hen. Almost the only chance of seeing one of these wary birds is by sitting still and patiently waiting under cover of a bush near the water's edge.

It can at once be distinguished by its peculiar stooping attitude and its short, unwebbed toes. The mode of walking, too, is rather peculiar, the little white-tipped tail being jerked upwards at each step, in a manner which much reminds the spectator of the action of a rabbit when running.

In his work on *The Birds of Ireland*, Mr. Thompson mentions a case which shows that the water-rail is, in spite of its shy habits when at liberty, even more capable of domestication than the water-hen.

He saw in a gunsmith's window at Belfast a water-rail running about in the window, and picking off the flies from the glass. It resented any interference, and when a hand was placed near it struck fiercely at it with beak and feet. It seemed so thoroughly at home that Mr. Thompson was quite surprised when he found that it had only been captured on the previous day.

CHAPTER IX

THE WAGTAIL, THE CUCKOO, THE SEDGE-WARBLE, AND THE REED- WARBLE

WHAT brook is complete without its wagtails, those graceful, lively, and prettily coloured little birds which are to be seen wherever a few inches of water exist? Brook, river, lake, or pond are all the resorts of the wagtails, whose food is mostly found at the edge of the water.

The **Pied Wagtail**, sometimes known as the **Dish-washer** (*Motacilla Yarréllii*), is the commonest of the five species known to inhabit England. In France the wagtails go by the popular name of *Lavandières*, or Washerwomen, in allusion to the Continental custom of washing linen at the bank of a stream. In general shape, though not in colour, the wagtail looks very much like a magpie seen through the wrong end of an opera glass, its long tail being very conspicuous.

The bird seems absolutely incapable of keeping its tail quiet, and immediately on alighting from the wing, or when tripping over the ground in pursuit of insects, flirts its long tail up and down with a peculiar jerking movement that can be recognised at a considerable distance. Why this bird should wag its tail up and down, while the duck wags its tail sideways, no one can conjecture.

Its flight is as peculiar as its walk, the wings being so short that at every stroke it sinks down towards the ground, so as to describe a series of deep curves as it flies. It seems to be a most restless little bird, running here and there, picking right and left, and flitting about with ceaseless activity. Roads that happen to run near water are favourite resorts of the wagtail, as there the bird can find plenty of the little insects on which it lives.



PIED WAGTAILS.

Now and then it seems to borrow some of the habits of the flycatcher, perching on a stone and leaping into the air after the insects as they fly past it.

If you look closely along the banks of the brook, you will probably come upon the nest of the wagtail. It is carefully hidden, and you may have some trouble in finding it. The bird is not very particular as to the exact locality in which it places the nest, sometimes

making it among the long grass, sometimes putting it among stones, and often placing it in a hole of an old wall. It is made of withered grass, fibrous roots, and leaves, and is lined with various kinds of hair. Altogether it is a careless sort of nest, and displays none of the trim neatness which distinguishes that of the dipper. Indeed, it is hardly superior to that of the campagnol.

The Cuckoo (*Cuculus canorus*).—In one respect, however, the wagtail's is more interesting than the dipper's nest. The eggs of the wagtail are greyish white, speckled with brown. But among them may sometimes be seen an egg of much the same size, but of a dark grey, thickly mottled with reddish brown. This is the egg of the cuckoo, that very remarkable bird which, instead of building her own nest and rearing her own young, lays her eggs here and there in the nests of other birds, leaving to them the task of rearing them.

The oddest point in the life-history of the cuckoo is the great discrepancy between the size of the cuckoo and that of its egg. The cuckoo is about as large as the kestrel, and, indeed, has often been mistaken for a hawk ; yet its egg is no larger than that of a sparrow, the object of the very small size being to enable the cuckoo to place its eggs in the nests of the various little birds which are chosen for this purpose. Birds seem to have but little sense of colour ; for one of the birds whose nest is most frequently chosen by the cuckoo is the hedge-sparrow, whose eggs are blue, and quite unlike those of the cuckoo.

How the cuckoo contrives to place her eggs in so small a nest was not known until lately. Now it has been ascertained that the cuckoo first lays her egg on the

ground, and then takes it in her mouth and lays it gently in the nest of the foster-parent. The egg being so small, the young cuckoo when first hatched is no larger than the young wagtail, redbreast, or hedge-sparrow; but, like the crocodile, which grows to a length of sixteen feet or so, and is hatched from an egg scarcely larger than that of a Muscovy duck, the cuckoo grows with wonderful rapidity, so that there is not room in the nest for itself and the rest of the young.

Finding itself crowded, the cuckoo deliberately pushes its foster-brethren out of the nest, and soon grows so large that there is scarcely room enough in the nest even for itself. That it should be able to perform such a feat at so tender an age seems so unlikely that for a long time no one would believe it to be possible. However, it has often been watched, and the fact has repeatedly been proved. In the *Field* newspaper of July 28, 1883, the following communication appeared :

‘A water-wagtail has lately built her nest in a flower-box at my window. She began to build about June 17, and on the 25th I saw a cuckoo fly in and lay an egg in the newly finished nest. On each of the four following days the water-wagtail laid an egg, and two I took out of the nest. She began at once to sit on the three remaining eggs, and on July 11 and 12 they were all hatched.

‘When two days old the cuckoo turned one of the water-wagtails out of the nest, and on our replacing it he turned them both out. The water-wagtail continued to feed the young cuckoo with great care, and one day she brought him a yellow butterfly. She chopped it up with her beak, but the cuckoo would not swallow it until

he had the whole of the butterfly in his mouth.—F. H., Haffield, Ledbury.'

It is a remarkable fact that this habit of laying eggs in the nests of other birds belongs only to the cuckoos of the Old World, those of America making their own nests and looking after their own eggs, as respectable birds might be expected to do.

Mr. H. Bowdler Sharpe, the well-known ornithologist, explains our cuckoo's habits in a very simple and interesting manner. Some little time before these lines were written he delivered a lecture at the Midland Institute, Birmingham. He stated that 'from his own experience he believed that there were at least five males to every female cuckoo that visited this country. The audience would therefore see that there were four unfortunate male cuckoos who could not find a wife, and the consequence was that the female bird was continually chased by every one of the males, each requesting her to marry him and build a nest.

'In America there were not so many male birds in excess of the female, and the consequence was that the cuckoos in that country built their own nests. The American cuckoos did not lay their eggs and hatch them all at once, as most English birds did, but would lay them at intervals, leaving the young birds first hatched to hatch the remainder.'

Cuckoos' eggs, although they are rather prized by collectors, are much more common than is generally supposed, as may be imagined from the fact that they have been found in the nests of at least ninety species of birds. My eldest son once took two cuckoos' eggs out of the nest of the same hedge-sparrow, the second having

been laid two days after the first. I have also heard of two cuckoos' eggs having been placed simultaneously in one nest. These were probably laid by two separate birds. I believe that many of the cuckoos' eggs which are found are mistaken for those of the sparrow, and are, therefore, destroyed.

Again, I have noticed that in some years these eggs are tolerably plentiful, while in others scarcely an egg is to be found.

Watching the proceedings of the young cuckoo and its foster-parents is a most interesting task, but one which is very difficult of accomplishment. The nest must, as has already been mentioned with regard to the kingfisher, be in your own domains, where mischievous boys will not be allowed to meddle with it. Even when we are fortunate enough to possess a spot where the birds can be protected and where a cuckoo has laid its egg, there is still another enemy which is nearly as formidable as a boy, and that is the cat. Pussy is a charming animal, and I am very fond of her ; but she is a determined bird-hunter, and nothing delights her more than getting hold of a nest of young birds.

Whenever the egg of the cuckoo is found, it should be carefully protected, as the bird does inestimable service to agriculture.

Coming to this country in the spring, when the leaves are green and tender, it feeds almost wholly on caterpillars, especially the great hairy larvæ of the tiger-moth, which are so familiar under the title of 'woolly bears.' It also eats the larvæ of the vapour-moth, which does such damage to fruit-trees, and whose clothing of stiff, bristly hairs, arranged in bundles, is an effectual pro-

tection against any bird except the cuckoo. So if you should be fortunate enough to have a brook running through your own grounds and to find the nest of a wag-tail, or, indeed, of any small bird, you should keep a careful watch, in hopes that a cuckoo may deposit an egg in the nest.

The mention of watching the nest brings me to another point. Ever observe Captain Cuttle's golden rule, 'When found, make a note of.' Never be without your note-book and pencil, and never omit to note down even the most trivial incident. The day is tolerably sure to come when that little incident will prove to be of inestimable value, and may, perhaps, be the means of settling some disputed point in Natural History.

The value of your note-book will be doubled if you can draw, however rudely, the object which you are describing. You may probably be ignorant of its name, so that the incident will have no scientific value; but the sketch, together with the description, will enable an expert to identify the object, and so to make your notes a valuable contribution to science.

The habit of invariably sketching everything which you notice will be of the greatest personal service to you. It is comparatively easy to make a sketch of a tree or a flower, about which you can take as much time as you like; but when you have to sketch a living creature, and especially when you wish to represent it in action, you must acquire the art of seizing the salient points and transferring them at once to paper, leaving details to be filled in afterwards.

If you happen to have seen the rough sketches which were taken by the artists of the illustrated journals upon

the field of battle, you will understand the value of this art, which can only be acquired by constant practice.

The Sedge-warbler (*Sylvia phragmitis*).—Should the brook be one of those which are favourable to the sedge and reed, there is another bird whose nest may mostly be found, and who is often obliged to play the part of foster-parent to the cuckoo. This is the pretty though soberly coloured bird known by the name of sedge-warbler. It is quite a little bird, only measuring five inches in total length. Its colour is simply brown of one or two shades above, buff on the breast and abdomen, and white on the throat. These sombre colours, together with its retiring and shy habits, render it invisible to the casual passenger, while those who are familiar with its ways have no difficulty in observing it.

While I was at Oxford, and in the habit of spending much of my Long Vacation on or in the river, I became quite familiar with the sedge-warbler. In many places the reeds and sedges grew so luxuriantly that I often used to drive the boat among them till it was nearly hidden by the dense foliage, and there, myself hidden, was able to watch many a denizen of the water and the bank.

Among this herbage the sedge-warbler was usually to be found, though less seen than heard. It mostly kept itself within shelter of the reeds, seldom even showing itself above their tips. When there was a blank space, the sedge-warbler would occasionally flit across it for a moment in its peculiarly restless manner, and immediately disappear among the sedge-blades. It is very liberal of its little twittering, guttural song, especially towards evening.



The Reed-warbler.

Although the cuckoo manages to find the nest of this bird, human eyes have some difficulty in detecting it, as it is always well sheltered, and often placed in situations where it can only be approached by wading. A favourite position for this nest is a spot on the bank where it is overshadowed by a bush above and sheltered by reeds or sedges below. The eggs are pale brownish-yellow, mottled with dark brown, and are sufficiently like those of the cuckoo to excuse the bird for failing to detect that of the intruder.

The Reed-warbler (*Salicaria arundinacea*).—Another most interesting bird may be found in similar localities. This is the reed-warbler, sometimes called the reed wren. In colour this bird somewhat resembles the sedge-warbler, but may be distinguished by the redder hue of its back and the white streak over the eye.

Like the preceding bird, the reed-warbler is by no means uncommon, though seldom seen except by those who know where and how to look for it. Following the same tactics as the coot, it makes its nest at some distance from the land, and places it in the thickest clusters of reeds, where it can with difficulty be seen, and where, even when detected, it can scarcely be approached, even in a boat.

The bird gathers together three or four of the strongest and tallest reeds, and weaves its beautiful nest upon them, always placing it at a considerable height above the water. Now the reed is proverbially flexible, and bows unharmed before the storm which tears the branches off the elm and uproots the oak. What then is to become of the eggs and young of the reed-warbler?

If you walk by the brook-side on a stormy day, you

may see the reeds all bending before the wind until their tips nearly touch the surface of the water. Among them will probably be several nests of the reed-warbler, and yet not an egg or a young bird will be flung into the water. This result is attained by the peculiar structure of the nest, which, instead of being cup-shaped, as is the case with most of the warblers' nests, is exceedingly deep in proportion to its width, so that even in the severest gale, when the reeds are flung about like so many whips by the force of the tempest, the contents of the nest are retained within it.

CHAPTER X

NET FISHING—THE WHIRLIGIG BEETLE

Now let us find some spot where the surface of the brook is smooth, where it is well sheltered from the wind by bushes or luxuriant herbage, where the sun can shine into the stream, and where we can lie on the bank so as to bring our eyes close to the surface of the water. Look steadfastly into the water, and try to penetrate its depths. For the first few minutes you will probably see nothing, and may be inclined to think that there is nothing to be seen. This, however, is a mistake, the fact being that human eyes require some little training before they become fitted for water-gazing. So do not be disheartened, but continue to gaze.

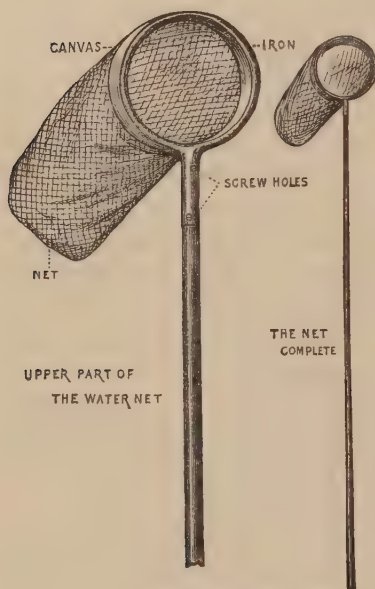
Before long you will first see one living creature traversing the depths. Then another will come into view, and another, and another, until at last the water, which at first seemed quite empty, will be seen to be absolutely teeming with life.

Which creature shall we take first? The answer to this question depends very much on the time of year. Let us suppose, then, that we are in the spring-time, say about the middle of April, and that the weather has been warm and auspicious to animal life.

Net Fishing.—Here I must mention that, however closely we may watch the creatures in the brook, we must mostly remove them out of it if we wish, as we ought to do, to study them minutely. For this purpose we shall want a net, and had better make it for ourselves.

The flimsy affairs which are recommended in the shops are simply 'made to sell,' and are practically useless.

The handle of your net should be at least five feet in length, made of the best ash, and not less than five-eighths of an inch in thickness. In using the net you are sure to include a quantity of heavy weeds, mud, etc., among your captures, and a slighter net will break with the strain.



WATER NETS.

Next, get a blacksmith to make a ring of iron, nine inches in diameter, about as thick as an ordinary brass stair-rod, and weld it firmly to an iron socket about four inches in depth, and just large enough to allow the end of the handle to be forced into it. Two holes should be made in the socket, one within half an inch from the

mouth of the socket, and the other about three inches from the first. These are for the reception of screws, and it will be as well not to have them in the same line, so as to avoid the danger of splitting the wood. Give the iron portions two or three coats of Brunswick black to protect them from rust.

The net itself should be made of mosquito net, and be ten inches in depth. It must not be pointed, but very carefully rounded at the bottom, as otherwise you will find great difficulty in taking out the creatures which you may capture, and which, as you will find, have a persistent way of crawling into the smallest crevice that will receive them.

The net should not be sewn directly on the ring, as it would soon be worn to pieces by the friction to which it must be subjected. The best plan is to fit a strip of very stout canvas upon the ring, and then sew the net to the canvas. If the brook should be at a distance from your house, you will find the net rather troublesome to carry, besides drawing upon you the rather obtrusive attentions of an unsympathetic public. Hence the recommendation to fasten the net to the handle by screws. Before you start you can remove the net from the handle, and so can carry both without attracting much notice. Small thumb-screws are the most convenient for this purpose, as they can be removed and replaced without the use of a screw-driver. A still more convenient form is the 'folding ring' net, which can be obtained from any of the dealers. It has the advantage of folding into a compass so small that it can be put in the pocket when withdrawn from the net. It is not, however, so strong as the simple ring and socket; and should one of the

hinges be broken, it must be sent back to the maker for repair, whereas any village blacksmith can make or mend a ring and socket.

Of course you must take with you a vessel in which to place your captures. The tin cans which are made for the express purpose are the best ; but, in any case, it is necessary that the vessel shall be quite dark, as the inhabitants of the brook are not only quarrelsome but carnivorous, and in many cases cannibals, so that they are sure to fight if they can see, and in many cases will eat each other.

Some little art is required in the right use of the net. You may see two persons hunting the same brook and using the same net ; and yet, while one captures specimens by the hundred, another will find nothing. If you plunge your net into the water with a splash, snatch it out with a jerk, and plunge it in again with another splash, you will frighten away all the animals, instead of inclosing them in the net.

You cannot be too gentle while brook-hunting. When you have marked down a spot which you think will be tolerably promising, slip the net very gently into the water at some distance from the spot, and coax it, so to speak, towards the required locality, so as not to alarm the inhabitants. Then draw it firmly and steadily through the water, turning it and drawing it backwards and forwards several times.

On lifting it out you will probably find it partly choked with evil-smelling mud, among which a number of indefinite living forms are seen writhing and twisting, or, as our American friends say, 'squirming,' like a handful of earthworms or a basketful of live eels.

You cannot examine them while they are covered with this mud, neither can you place them in your collecting can, because they would make the rest of the inmates as dirty as themselves. You must wash them thoroughly before attempting to examine them ; and for this purpose all you have to do is to dip the net repeatedly into the water, holding it up and letting the water drain from it. When the water which runs away is quite clear you may begin to investigate the contents.

In the search, always use your fingers, which were made before forceps, and in this task are much more useful, the sense of touch often detecting creatures which had eluded the sense of sight. You must not mind getting your hands dirty. There is plenty of water about, and you can wash them as often as you like. Moreover, the mud of a brook is equal to the best soap for its cleansing properties, and costs nothing.

Another axiom. Nothing that you can catch in a net can hurt you, so that you may handle them all impartially, without fear. Some of them, it is true, have rather a formidable aspect, and look very much as if they could sting. But set your mind at rest. No inhabitant of the fresh water can sting, and none of them can bite hard enough even to injure a young girl.

Take every creature which you do not know, 'handle him as if you loved him,' according to Izaak Walton's receipt, and put him, or her, or it, as the case may be, into your collecting-can, to be examined hereafter. If you should already be acquainted with your captive, follow Dogberry's advice, very slightly altered, 'take a note of him, and let him go.' Never kill any being unless its death may be serviceable to man ; and if

you do not need any of your captives, make a note of that creature, and throw it back into its native stream.

At home you should be provided with a number of vessels, half-filled with water, to which you can transfer your captives. You can hardly have too many of these vessels, which you may call *aquaria* or *vivaria* if you like, as many creatures must be kept alone. Place no reliance on the picturesque groups which are so often figured, and which represent dragon-flies, butterflies, water-beetles, frogs, newts, and other miscellaneous beings all gathered together into a sort of 'happy family.' Your policy must be of a totally different character, and must be one of isolation.

It may be said, and often is said, 'I only follow Nature, and gather together in my vivarium the identical creatures which are gathered together by Nature in the brook and on its banks.' This argument is plausible, but not sound. The conditions are not the same. No aquarium or vivarium, or a combination of both, called learnedly by the name of 'aquavivarium,' can fulfil the same conditions as are found in the brook.

In the first place, space is limited, whereas that of a brook is, in comparison, illimitable. Then the various creatures are deprived of their natural food and shelter, two very important elements in animal life. Again, the water is small in quantity, whereas in the brook the water is incessantly renewed, and is always more or less in motion.

Having washed your 'catch' thoroughly, you can proceed to examine it in detail.

THE WHIRLIGIG OR WHIRLWIG BEETLE 111

The Whirligig or Whirlwig Beetle (*Gyrinus*).—There is one creature which you are tolerably certain to find everywhere. I might almost have written the word 'absolutely' instead of 'tolerably,' but one result of experience is to teach the danger of employing such sweeping terms. At all events, I have been a practical brook-hunter for some fifty years, and never met a brook the waters of which did not swarm with the larva, or grub, of the whirligig, to which a casual allusion was made in the opening chapter.

Every one who has walked by the side of any brook must have been amused and interested by these restless little beetles. They are gregarious in their ways, and you will scarcely ever see a solitary specimen. They are wonderfully hardy, and even in the winter time, when most insects, except themselves, are either dead or hibernating, the whirligigs are as lively as ever, provided that they can find a sheltered piece of water, no matter how small it may be.

Viewing these beetles as they openly skim the water in their peculiarly conspicuous manner, one naturally feels some surprise as to the cause of their immunity from destruction. Below them, under the surface of the water, are shoals of hungry fish, ready to snap up any insect that may fall into the water. Yet no fish ever is known to allay its hunger with the whirligig beetle.



LARVA AND IMAGO OF THE
WHIRLIGIG BEETLE.

There are plenty of hungry birds, which might easily snap it up from the surface of the water, or pounce on it as it flies through the air on its long and beautiful wings. Yet no bird, when dissected, has ever been known to have the remains of the whirligig beetle in its crop.

It owes its safety to two peculiarities. In the first place, the shining armour in which it is clad is so thick and so hard that there is but little room for the soft tissues which render an insect worth eating. In the next place, it is endowed with an odour which may either not be perceptible to itself, or even actually pleasing, but which, to all other beings, is singularly repulsive, so that neither fish nor bird will eat it.

As we shall be able to examine this beetle in all its stages of life, we will first take its larva, as it appears in the net. No one could even conjecture from the appearance of the larva what sort of insect it represented, and there is as much difference between the larval and perfect forms of the whirligig as there is between the caterpillar and the butterfly.

The larva is a long-bodied grub, with six little slender legs ; soft-skinned, with the exception of the head and the three segments, or body-rings, which represent the future thorax ; feeding on decaying substances, sluggish in its movements, and breathing by means of forked, external gills, which look like a row of white feathery forks along each side of the body. When taken out of the water it looks a most ungainly creature, the gills clinging to the sides, and entirely altering its appearance.

The best mode of making it show itself to the best advantage is to place it in a tall, narrow, glass jar filled with water. In order to breathe, the creature must have

THE WHIRLIGIG OR WHIRLWIG BEETLE 113

its gills continually washed with fresh supplies of water. In the running brook there is no need for the larva to use any exertion when breathing, but when placed in the still water of the jar it must either exert itself or die. Its mode of supplying itself with oxygen is very simple. Its body is as flexible as that of an eel, and in swimming is used in the same manner—namely, a kind of serpentine undulation, which carries it swiftly through the water.

Having thus wriggled itself to the surface of the water, it spreads out its gills and sinks slowly, so as to bring its outstretched gills in contact with as much water as possible. While floating slowly downwards it is a singularly graceful creature, the white translucent gills having a beautiful effect as the light shines through them, and presenting a wonderful contrast to the mean and draggled aspect which they present when the larva is removed from the water.

After attaining its full growth, the larva ascends the stem of some aquatic plant, and comes to a halt when it has crawled a few inches above the surface of the water. Having attained a suitable spot, it spins an oval cocoon around its body, so that it loses all appearance of an insect, and looks like a lump of mud that has accidentally stuck upon the leaf. Within this cocoon it undergoes its development into the perfect state, and then issues from its cover in the form with which we are so familiar.

Here I must call the attention of the reader to two points—namely, the growth and the respiration, about both of which much misapprehension prevails.

When I stated that the whirligig attained its full growth in the larval state, I did so intentionally. The whole of the growing is accomplished during the larval

state, and when once the insect has passed out of the larval condition it grows no more. Most people think that a little fly is a young one, and that, if it should live long enough, it will become a large fly. In point of fact, the fly will grow no more. It did all its growing when it was larva, or maggot, and when it had attained its full growth it weighed much more than it weighs as a fly.

INSECTS NEVER GROW.

It is over thirty years since I made this statement in similar type, so as to attract attention, and yet I am in the continual receipt of letters calling my attention to the statement, and doubting whether it can be true. Sometimes I receive a box containing four or five humble-bees, together with a letter couched in such terms as these :

‘SIR,—

‘You say in your *Common Objects of the Country* that insects never grow. *It is not true!* I took these humble-bees out of one nest, showing them in different stages of growth.’

Or, I receive a box containing a number of cockroaches, all of different sizes, together with a letter :

‘SIR,—

‘You say in your *Common Objects of the Country* (page 70) that insects never grow. You do not understand what you are writing about. Sir, did you never see blackbeetles in your life? As you seem not to have seen them, I send you a lot which I caught myself in my

THE WHIRLIGIG OR WHIRLWIG BEETLE 115

kitchen, and they are all of different sizes. Insects do grow, and you are quite wrong. I hope that you will publish this when you write again about insects.

‘Yours indignantly,
‘A. B.’

I can assure the reader that these are genuine letters, and that they are fair samples of my usual correspondence on this subject. I have no doubt that other entomologists are persecuted after a similar fashion. The mistakes of both these correspondents were due to their ignorance of the insects of which they wrote.

As to the humble-bees, they, like the hive bees, ants, and wasps, belong to the Social Hymenoptera, in which the females are so modified that there appear almost to be three sexes. First come the males, which are known in the hive bee as ‘drones’; then come the fully developed females, which are called ‘queens’; and lastly come the partly developed females, which are called ‘workers.’ Now, the queens are always the largest of the three; then come the males; and the workers, who constitute the bulk of the community, are the smallest of all. The ants have a further subdivision among the workers, the largest being the soldiers, and the smallest the labourers.

But, when once they have passed out of their larval state, no matter whether they be males, females, or workers, they grow no more. One of the most striking examples of this fact is to be found in the Termites, which belong to another order of insects, and in which the queen is many hundred times larger than the worker. Although she does not really grow, she appears to do so,

on account of the great elasticity of the skin of the abdomen, which stretches as if it were made of india-rubber, so as to accommodate the vast quantities of eggs which she daily supplies for the purpose of keeping up the population of the nest.

As to the cockroaches, the mistake was of a different character. They belong to the same order as the crickets and grasshoppers—namely, the Orthoptera, or straight-winged insects—which retain very much the same shape throughout their different stages of existence. The Lepidoptera, *i.e.* the butterflies and moths, present a totally different appearance in their three stages, so that no one can doubt whether the creature be a caterpillar (or larva); a chrysalis (or pupa); or a butterfly. But, when the Orthoptera are first hatched from the egg they look much like the perfect insects, the chief distinction being that they have no wings. The same mode of growth belongs to the locusts, the wingless larvæ of which are called at the Cape by the expressive name of ‘voetgangers,’ or foot-goers, and are even more destructive than in the winged state.

Now we will revert to our whirligig beetle, and give a few lines to the respiration of insects. This is a most interesting portion of their life-history. I have mentioned that the larva of the whirligig beetle breathes in water by means of gills, as is the case with the larvæ of many insects. But all insects breathe atmospheric air, doing so, not by lungs, as we do, but by means of a most complicated network of air-tubes, which divide, and subdivide, and ramify throughout the entire body, even extending through the antennæ, the legs, and the wings. The wings, indeed, are not modified limbs, as in the bats

and birds, but are prolongations and extensions of the air-tubes, so that the insect is, in fact, a living lung endowed with limbs.

The mode by which these tubes are used is most remarkable. When the vertebrated animals breathe they produce a vacuum in the chest by expanding the ribs (or, as is the case with the frogs, toads, and newts, by expanding the hyoid bones at the base of the tongue). But the insects have no bones, and therefore must have some other mode of producing the needful vacuum. This is the way in which the insects breathe.

The body is composed of a number of half-rings, set in this  fashion, and having the space between them filled in with a very elastic membrane, so that the upper and lower halves of the body can be separated from each other. In this membrane are certain oblong holes, called 'spiracles,' which admit air to the tubes. When the insect expands its body, by separating the upper and lower halves, it causes a vacuum, so that the air rushes into the tubes through the spiracles. Then it is expelled by means of the muscles which contract the body, and thus the act of respiration is accomplished.

The popular ideas on this subject were well expressed by an advertisement of a certain fly-poison which appeared a few years ago. According to the advertisement, no sooner did a fly put its nose near the poison than it fell down dead from merely smelling it. Now, insects have no noses, nor does air enter the system through any part of the head.

See, then, what a wonderful change has taken place in the insect, which, while a larva, breathed water by means of gills, and, when a perfect insect, breathes atmospheric air

by means of a system of tubes. We shall frequently have to refer to the respiration of the inhabitants of the brook.

Now, take a whirligig out of the water, and examine it closely. Here I may mention that no student of Nature is complete without a magnifying glass, the ordinary pocket lens being amply sufficient for field purposes. Of course, if you have a microscope at home, so much the better; but this treatise deals exclusively with field work, and, so, all that the wanderer by the brook will require is the little lens with two or three glasses, which can be carried in the pocket.

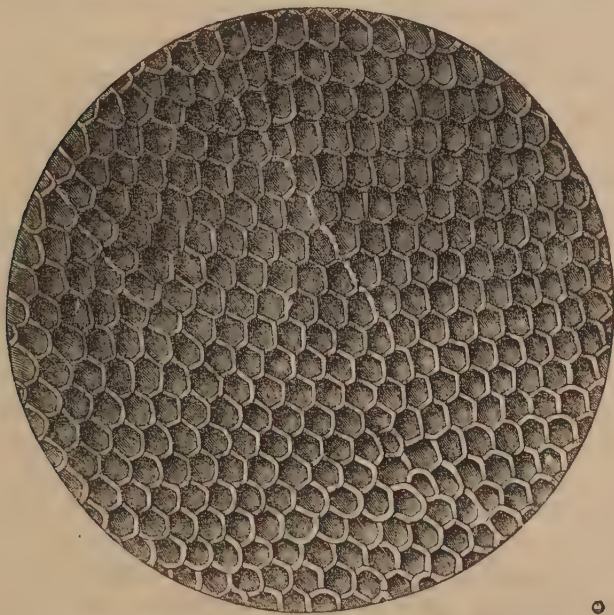
With this lens examine the whirligig, and first look at its legs. The first pair are long and slender, while the second and third pairs are very short and flattened, so as to convert them into paddles. Here I must observe that however much the legs of insects seem to differ from each other, they all possess the same joints, though those joints may be modified in accordance with the task which they have to perform. Few persons would think, when viewing these legs of the whirligig, that the long front legs and the short, flattened intermediate and third pairs are formed of exactly the same joints.

Insects are divided into three distinct portions. First comes the head, which carries the organs of sense; next comes the thorax, which carries the organs of locomotion; and lastly comes the abdomen, which contains the vital organs.

First, taking the head, we see that it comprises the external jaws, or 'mandibles,' the inner jaws, or 'maxillæ,' together with the antennæ, 'horns,' or 'feelers,' as they are sometimes called, and the peculiar appendages which are called 'palpi,' or lesser feelers.

THE WHIRLIGIG OR WHIRLWIG BEETLE 119

The eyes are 'compound,' *i.e.* composed of many lenses, varying in number from eight or ten on each side to as many thousands. The well-known Scarlet Admiral butterfly has about fifteen thousand lenses on each side, every lens having its own branch of the optic nerve.



EYE OF WATER BEETLE (HIGHLY MAGNIFIED).

○
EYE OF WATER BEETLE
(NATURAL SIZE).

Next comes the thorax, which is subdivided into three parts—namely the 'prothorax,' the 'mesothorax,' and the 'metathorax.' Each has its peculiar office. The prothorax (or front of the thorax) has nothing to do except carry the first pair of legs. The mesothorax (or middle of the thorax) has a more complicated duty. The upper

portion carries the first pair of wings (which in the beetles are never used for flight, but are thickened into 'elytra,' or wing-cases, under which the flying wings are packed when not in use). The lower portion contains the middle or intermediate pair of legs, and half of the sockets for the last pair. The metathorax (or last portion of the thorax) contains in its upper part the second pair of wings, and in its lower part the other half of the sockets of the intermediate legs, and the third or last pair of legs. No matter how much they may be modified, these structures are the same in all insects. Lastly we come to the abdomen, in which the rings, of which every insect's body is composed, are seen more clearly than on any other portion of the body. On each side of the abdomen may be seen the oval spiracles, or breathing-holes, which have already been mentioned. In order to prevent dust or other foreign substances from getting into the spiracles, their openings are guarded by stiff bristles, which cross each other and allow the air to pass, although they exclude dust. Now we will examine the structure of the leg, taking one of the hind legs as our type. Next the body of the insect is the 'coxa,' usually quite a little joint. Then comes the 'trochanter,' a small and exceedingly variable joint. Then comes the 'femur,' or thigh, which is usually, though not always, the largest joint of the limb. Next comes the 'tibia,' or shank; and last of all is a row of five small joints, called the 'tarsus,' or foot, the last joint being furnished with two claws.

In order to impress these details more firmly on your mind, take the legs of several different insects, and work out the joints in each. Now look again at the legs of

THE WHIRLIGIG OR WHIRLWIG BEETLE 121

the whirligig, and ask yourself why the legs should be so different in character. The answer is simple enough. The beetles do not keep up their incessant scurry over the water for mere play; they are engaged in very earnest work—*i.e.* searching for food. They feed on small insects, especially those which fall into the water or are blown into it by the wind. They also feed on the smaller aquatic insects, the two hinder pairs of legs acting as paddles, by which they are driven through the water, and the front pair of legs helping them to seize their tiny prey. It is rather amusing to watch a group of these beetles, and to trace the course of any one of them. It is a most bewildering task, any one of them on which you happen to fix dodging in and out among its comrades, and reminding the observer of the Irishman's pig, which ran about so fast that no one could count it. Moreover, the insects have a habit of diving as suddenly as the dabchick itself; so that to keep count only of a dozen or so is next to impossible.

Now turn your attention to the head, and look at the eyes. You may be surprised to see that to all appearances it has four sets of compound eyes, instead of two. If, however, you were to dissect the beetle, you would find that there are really only two eyes, but that each of them is divided into two sets by a thick horny partition, one set being always submerged as the beetle swims on the surface of the water, and the other set being above the water. The reason for this remarkable variation in structure is that the insect requires to see objects which are either above or below the water. Now, as we all must know, if there should be the slightest ripple on the surface of the water, every object beneath the surface is

rendered invisible. Fishermen who are obliged to look out for fish, such as the cod, which live at some depth, have invented a simple instrument, called a 'water telescope,' by which the effect of the wind upon the surface of the water is neutralised. It is nothing but a metal or wooden tube, at one end of which a piece of plate glass is fixed, so as to prevent water from entering the tube. When the day is windy, so that the men can see nothing below the surface, they push the glazed end of the tube under water, and then, by applying the eye to the other end, they can distinguish objects as plainly as if the weather were perfectly calm. If you like, you can have a water telescope made at the cost of a few shillings. If the tube be of wood, it may be about three feet in length, and shaped like a hollow obelisk, with one end much larger than the other. The glass is inserted into the large end, and it will be as well to have a heavy band of lead fastened round the large end, as otherwise you will find that to keep the instrument immersed will cause so much exertion that it will be impossible to obtain a steady view of the creatures below the surface. Should you prefer a metal tube, it should be made in the form of a cone, so as to give a wide range of vision. It is a delightful and fascinating instrument; but it has one drawback. It is necessarily heavy, and its conveyance is not easy. However, those who study Nature must make up their minds to expect inconveniences, and to put up with them without grumbling.

I hope that the reader will not fail to have observed that the whirligig beetle shows how man might have learned the use of the paddle and the water telescope, the insect employing them both for the same object—

THE WHIRLIGIG OR WHIRLWIG BEETLE 123

namely, the capture of prey in the water. I do not say that man did borrow either of these implements from the insect. It is not likely that he did anything of the kind ; but it is evident that he might have done so, and that the whirligig had used the paddle and the water telescope for ages before man discovered them.

CHAPTER XI

BROOK FLIES

LET us take another look at the contents of our net. Here are several long-bodied, hairy-legged grubs with three bristles at their tails, such as are shown in the accompanying illustration. These are the larva of the Mayfly.

The Mayfly (*Ephéméra*).—There are many kinds of mayfly, but the life-history of them all is nearly identical.

These insects are proverbial for the shortness of their lives, and the name of *Ephéméra*—*i.e.* ‘for a day’—is highly appropriate, as they seldom see a second sun. Still, although their life in the perfect state is so short, they have spent at least two years in the water before they received their wings.

Now let us examine one of these larvæ. Like that of the whirligig beetle, the larva of the mayfly breathes by means of external gills, which are set along the sides, and which cling so closely to the body when the creature is removed from the water that their very existence would hardly be suspected.

These larvæ are slow in their movements, so that you will seldom make a sweep with your net without capturing several specimens. Look at their mouths, and you will see that they are large, and furnished with tolerably

powerful jaws. I lay special stress on this point, as when they attain to the winged state they have no mouths, not requiring nourishment during the short hours of their winged life.

You are not likely to catch any large specimens of these larvæ, because they seldom leave the protection of the bank. If you should wish to procure examples of these larger specimens, your best plan will be to look out for a spot where the banks are muddy, and armed with a spud, or similar instrument, detach a lump of mud, break it up, and sweep the net vigorously through the muddy water. These larger specimens are known to anglers by the appropriate name of 'bank bait.'

The shape of the burrow is worthy of notice. Instead of boring a simple hole, the larva first drives its tunnel into the bank, and then, after it has penetrated in a straight line for an inch or two, it makes a curve, and re-enters the water, the shape of the completed burrow much resembling that of a horseshoe. Two objects are obtained by this form of burrow. One is that the creature is able to enter and leave the tunnel without being obliged to turn ; and the other is that the water flows freely through the burrow, so as to afford a sufficient supply of oxygen to the gills.

As may be seen by reference to the illustration, the pupa of the mayfly differs but little in point of external appearance from the larva ; the chief distinction being



LARVA OF AN
EPHÉMERA.

that the future wings become visible as four small pointed plates.

In the course of its long sub-aquatic life the mayfly changes its skin many times, Sir John Lubbock having observed a specimen of one of the smaller species change its skin no less than twenty times before it left the water.

The next scene in the life of a mayfly is of so extraordinary a nature that, unless it had been repeatedly witnessed, no one could have been expected to believe it. Yet, every one who has walked by a brook or a river when 'the fly is rising' has seen this astonishing sight.

The pupa climbs out of the water, its skin splits, and the winged insect emerges and flies away. But it does not fly far, taking the earliest opportunity of settling on any convenient object. The rough trunk of a willow is much favoured by the insect, the bark affording a good support for its feet. But it will alight on a stone, on a gate, or even on a human being, its claws adhering to the clothes.

After it has rested a while another change takes place. The skin splits a second time, and from it emerges the perfect mayfly as here shown, its wings having become much larger, and the three tail bristles having been drawn out to double their former length. Anglers know the mayfly by the name of 'Drake,' the first winged stage being called the 'Green Drake,' and the second form being known as the 'Grey Drake.' The perfect form of any insect is known scientifically by the name of 'imago,' but, as the mayfly has this double change, the first form is scientifically named the 'sub-imago.'

When the insects have thrown off the 'pellicle,' or delicate skin which enveloped them in the intermediate or sub-imago state, they betake themselves to the water,

and, hovering over it, continue to rise and fall over the same spot for hours together. Having nothing wherewith to sustain life, the males soon die, and the females, when they have deposited their eggs, die likewise, so that in a very short time not a mayfly is left alive out of the



PUPA OF AN EPHÉMERA.



IMAGO OF EPHÉMERA VULGATA.

countless myriads which joined for a few brief hours in their mazy dance.

When at rest, as well as when in flight, the extremely long and slender front legs are worthy of notice. They are so long and so slight that they look more like antennæ than legs, and are often mistaken for antennæ, like those of the insects which will next come under our notice.

In their numbers and times of appearance the mayflies are exceedingly variable. In some years scarcely a mayfly is to be seen, while in another year they issue forth in such multitudes that they really have the appearance of a snowstorm. For some days afterwards the tree-trunks will be covered with the shed skins of the sub-imago, which cling to the bark as if they were still living.

Some of the mayflies are quite small, and have only two tail bristles instead of three, while there are several species in which the lower wings are not developed, so that to all intents and purposes the creature is a two-winged insect.

Stone-Flies, Alder-Flies, or Willow-Flies.—Together with the larvæ of the mayflies the net is nearly certain to contain some creatures which, at a hasty glance, might well be taken for mayfly larvæ, with very thick bodies, and having spikes rather than bristles on their tails. These are the larvæ of the insects which are known by the popular names of Stone-flies, Alder-flies, or Willow-flies, one of them being familiar to anglers under the name of ‘Yellow Sally.’ Scientifically they are known as *Perlidæ*.

As is the case with the mayflies, there are many species of stone-flies, all of which have a similar life-history, so that the history of one species will equally answer for the others.

In their larval state the stone-flies are carnivorous, feeding largely on the larva of the mayfly, which seems to be a most unlucky creature in all the stages of its existence, the carnivorous aquatic creatures feeding upon it while it is in the water, and the birds and fishes

gorging themselves with it when it assumes its wings.

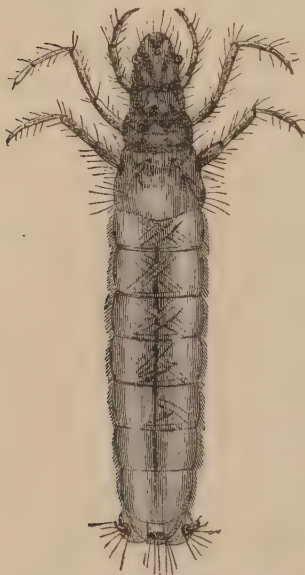
Owing to the great difficulty of rearing these creatures in captivity, and the impossibility of watching them in their native waters, the exact duration of their existence in the preliminary state is not definitely known, but there is little doubt that the stone-fly has at least two, and probably three years of life as a predaceous inhabitant of the water before it takes to the air, and then, like the mayfly, has no need of food during its short winged existence. It enjoys rather a longer span of life than falls to the lot of the mayfly, but does not live for more than four or five days, being quite incapable of taking food.

Although the expanse of wing in the stone-fly is considerable, the wings are very weak, so that it is a slow flyer, and is not able to indulge in the aerial dance which is so characteristic of the mayfly. The female insect has a remarkable habit of carrying her eggs about in the form of a rather large and very conspicuous knob at the extremity of the body. This egg-package is simply dropped into the water as the insect flies slowly above it.

The species which is known to anglers as the Alder-fly (*Sialis lutaria*) is allied to the stone-flies, but differs from them in some respects. It can easily be recognized, the smoke-brown wings being traversed by a great number of bold black nervures, quite unlike those of any other insect. It is extremely common, and in the spring may be seen absolutely swarming near almost any brook, or even pond.

It does not drop bundles of eggs into the water like

the stone-fly, but sets them in regular rows on reeds, rushes, and various other plants that are found near water. Sometimes these eggs are found so far from water that the larva, which breathes by means of gills, must traverse some space of dry land before it can



LARVA OF PHRYGANEA RHOMBICA.
(HIGHLY MAGNIFIED.)



PHRYGANEA RHOMBICA ON THE WING.



PHRYGANEA RHOMBICA IN REPOSE.

reach the water, where alone its gills can perform their office rightly.

This insect does not pass its pupal life in the water, but so soon as it has attained its full larval growth it leaves the water, burrows into the bank, and there remains until it undergoes its final change into the perfect form.

If the net should have been brought in contact with any of the water-plants, you will be nearly certain to find within it some of the singular objects called Caddis worms (*Phryganéidæ*), of which there are many British species.

Caddis worms, when in their perfect, or winged state, bear a considerable resemblance to the stone-flies, although, in fact, they belong to a totally different order, called *Trichóptera*, or 'hairy-winged' insects. They derive their name from the fact that their wings, instead of being simply membranous, like those of the dragon-flies, or covered with scales, like those of moths and butterflies, are covered with short soft hairs, giving them a peculiar silken gloss.

When the insect is at rest the wings are folded fan-like, so as to cover the body, as shown in the illustration, completely altering the contour.

The caddis-flies can run well on the surface of the water, and when I was a boy at school we used to amuse ourselves by getting up caddis races, each taking a caddis-fly, holding them in a row on the surface of the water, and then starting them together by signal. The pace at which a caddis-fly runs over the water is wonderful, the insect leaving a wide wake behind it.

The chief interest of the caddis, however, is confined to its larval and pupal stages of existence, especially the former.

As may be seen from the illustration (which is much magnified) the larva of a caddis is a fat, soft-bodied creature, with six slight legs, evidently incapable of swift movements, so that it seems liable to fall a prey to the many predaceous creatures which inhabit the

water. Were it as undefended as it appears to be from the figure, scarcely a single specimen could survive, for it is so fat and plump that every fish and each carnivorous inhabitant of the brook are only too glad to get at a caddis-grub, while its white colour makes it so conspicuous in the water that it could not hope to escape detection.

All anglers know how enticing a bait is a plump caddis-worm, even the wariest of fishes being unable to withstand the tempting morsel. However, although the brook may, and often does, swarm with the caddis, and with fish that are hankering after them, scarcely one of their number will fall a victim to a fish's appetite. Their Maker has gifted them with an instinct which enables them to bid defiance to any fish that inhabits the stream. They inclose themselves in cases made from an enormous variety of materials, each species having its own peculiar kind of case, although no two individuals made their cases exactly alike.

The character of the case differs according to that of the water. Some of the caddis-worms content themselves with finding a piece of hollow reed, biting it into a convenient length, getting into it, and living there. Others fasten together a number of pieces of straw, sticks, and similar materials laid longitudinally, while others dwell in a conical case made of sand-grains cemented together.

The variety of structure displayed by this creature is inexhaustible. Some years ago I made a large collection of these cases, but before long found that to exhaust the subject was a hopeless task. The bed of a brook receives all manner of *débris*, among which

the larva ranges with perfect impartiality. I have found the seed-vessels of various plants, broken pieces of bark, broken nutshells, the 'opercula' (of which we shall presently treat) of various aquatic molluscs, and even the chrysalis of a moth, all attached to the tube cases of this insect. I have heard that an elytron of a beetle has been pressed into the service of the caddis worm.

Another species of the same genus surrounds its tube with a sort of *chevaux de frise* of little strips of green reed, cut into short pieces of equal length. Others employ the tree-leaves which have fallen into the brook, cutting them into pieces, and fastening the pieces together, so that they bear some resemblance to a cabbage, the protruded head and thorax of the insect doing duty for the stalk.

Others, again, make their tubes entirely of sand-grains cemented together, and these cases are always conical and generally slightly curved, so that they resemble in shape the well-known tusk-shell (*Dentalium*) of our sea-shore. In a disused stone quarry in Wiltshire I found any number of these tusk-like tubes, but no other form of caddis case.

There is scarcely any kind of water that is not tenanted by the caddis, and the species vary in the same brook, according to the rapidity of the stream and the character of the soil through which it flows. In some places the caddis makes its protecting tube entirely of the shells of various aquatic molluscs, small shells of the Planorbis seeming to be the favourites. The oddest thing is, that the caddis does not in the least trouble itself to ascertain whether the shell be occupied

or not ; but, when it comes upon a shell of a suitable size, it fastens it to its case with the inhabitant inside it.

I have seen some very ludicrous results of this policy of annexation. A caddis had stuck on its tube some ten or a dozen shells, four or five of which were still tenanted by their legitimate owners. Now, it often happened that all the molluscs had protruded their bodies from their shells, each trying to walk in its own way, while the caddis was trying to walk in another.

On the river bed the caddis would probably have had the best of the struggle, but in an aquarium the glass affords no hold to the feet of the caddis, while these water-snails can cling tightly to the glass. Had the snails been of one mind as to the direction which they wished to pursue, they could have dragged their captor wherever they chose, but as each snail wanted to go its own way, while the caddis had but a single will to consult, the latter was victorious in the struggle.

Sometimes, when the bed of the brook is composed of clay, and the current is very sluggish, another species of caddis takes possession of the locality and makes its tube of mud, binding that very fragile material together with the same cement as that which is employed in fastening together the materials of the case, and which is necessarily insoluble in water. These cases are too fragile to be dragged about by their occupiers, and are therefore fastened throughout their length to some object which can support them, mostly a stick of some sort.

Not long ago I came on a whole colony of this species of caddis. I was specially hunting for the tadpoles of the frog and newt, and found the progress of the net

much hindered by some branches that had been thrown into the water and allowed to remain there. So I pulled out the obnoxious branches, threw them on one side, and went on with the net.

Having finished the search, I took up one of the wet and muddy branches, and looked along it, in order to see whether any inhabitants of the water had clung to it. The twigs were profusely studded with unopened buds, but no living thing appeared on it. I was just about to throw the branch away, when I noticed a circular hole at the upper part of one of the buds. On looking into the hole, I detected a sign of life, and then found that all these apparent buds were the habitations of a species of caddis. I shall presently revert to these remarkable structures.

Some very interesting experiments have been made by a lady, Miss Bree, upon the tube-making powers of the caddis.

She removed the larvæ from their homes, and then supplied them with a variety of materials. Being thus turned out of their homes, the larvæ made the best of existing circumstances, and built their cases with the materials which were given them. Some of these enforced habitations were exceedingly pretty, being made of fragments of variously coloured glass. She discovered that the caddis could not use its cement upon smooth surfaces, so that when she supplied the insects with glass beads they could make no use of them; but if she broke the beads, the broken surface afforded attachment to the natural glue. Some of these habitations were not only beautiful but costly, Miss Bree having supplied the larvæ with nothing but gold-dust.

When the ordinary caddis-worm sets off in search of food, it protrudes its head, thorax, and legs from the case, holding itself in its place by a set of strong claspers at the end of the body. The hermit crabs, which have soft bodies, and guard them by inhabiting the empty shells of marine molluscs, maintain their hold on the shell by a corresponding apparatus. There are some of the stationary species which need to protrude their bodies much farther from the case than is required by those which can wander about in search of food, and in order to enable them to do so the claspers are set at the end of long footstalks.

If you wish to evict the caddis for the purpose of preserving the tube, you can do so in a very simple way. The tube has an aperture at each end, so that water can flow through it and pass over the gills, that in the front being large enough to allow the front portion of the insect to protrude, and the other being very small, so that the inhabitant cannot be attacked from behind, where it is quite defenceless ; so, when you want to turn the creature out of the tube, push a pin through the smaller aperture. The caddis does not understand an attack from this direction, and after one or two un-availing attempts at resistance, quits the tube, and can then be set to work at making another.

Now we come to a very important phase in the life-history of the caddis. When the larva is 'full-fed,' as entomologists say, it prepares for a period of total rest. For this purpose it shortens its tube, and then closes the ends in such a manner that water can flow freely through it, while the helpless creature within is defended against its many enemies. How helpless

it is the reader may see from the illustration, which represents the pupal stage of the caddis-fly. The mode of defence varies in the different species, but it is mostly a strong silken web spun across the opening. The meshes of the web also differ according to the species, many of them being formed into artistic patterns which man might do well to copy.

The inhabitants of the mud tubes which I have already mentioned employed a totally different plan of closing their cases. Below the ordinary opening they made a dome-shaped partition of the same material as that of the case, leaving only a very little hole in its centre. The hole would scarcely admit an ordinary pin, so that no foe which the caddis could dread would be able to make its way into the case and destroy its helpless inmate. I need scarcely ask the reader to note the astonishing and minute care which has been taken by the Creator to insure the safety and happiness of one of the smallest of His creatures.

CHAPTER XII

WATER-BEETLES

IN every river, brook, lake, pond, and we might almost say in every puddle, we shall find examples of the enormous group of insects known by the comprehensive name of 'Water-beetles.' There are so many of them that I can only select a few of the most typical examples. They are denizens of earth, air, and water, and must therefore possess a very complex structure. Like many inhabitants of the water, they are interesting in all the stages of their existence, though the full beauty of structure is only to be seen in the winged or imago state ; and even then one requires the aid of a magnifying glass, if not of the microscope, before their full beauties can be manifested. The season of the year makes little difference to these hardy insects, which, if the water be clear, can be seen through thick ice, swimming merrily under the very feet of the skater.

The Great Water-Beetle (*Dyticus marginalis*) stands pre-eminent among them all. It is an insect that cannot well be mistaken for any other inhabitant of the water. It has but one rival in point of size, and from that rival it is easily distinguished by its colour, besides many important differences of structure. The colour of the male dyticus, which is shown as flying, is much



The Great Water-beetle.

more handsome than could be imagined by those who have never watched the insect disporting itself in the water, and illuminated by a brilliant light. In life, the general colour of the upper surface is deep olive-green, the wing-cases and thorax being edged with a border or stripe of yellow. Hence its specific name of *marginalis*—i.e. edged or bordered. These bright colours, however, as is the case with many creatures, belong only to the male; the female, which is represented as swimming, being rather larger, and of a dull brown. Her elytra, too, are covered with longitudinal grooves, while those of the male are smooth and polished, so that the two sexes are naturally taken for different species by those who see them for the first time. The generic name of *Dyticus* is Greek, and very appropriate, as it signifies a diver.

Now, supposing that a dyticus is one of the inmates of the net, we will examine its legs. Legs have three principal objects. Primarily they are intended for locomotion on land, secondarily for locomotion in water, and lastly as prehensile organs for the capture of prey. The dyticus is remarkable for possessing all three kinds of legs. First we will take the legs which are meant for locomotion on land. These are the middle pair, and are small and feeble, showing that the insect is not intended for travelling on land. In fact, it can hardly be said to walk at all, its pace under the most favourable circumstances being little more than an awkward hobble, the creature shuffling along by means of the roughnesses of the ground, and having but little power of guiding its course. If it be put on a perfectly smooth surface, such as a piece of glass, or even a china plate, it cannot walk

at all, but merely spins helplessly round and round on the same spot.

Next, we will examine the legs which are intended for progression in water. These are very large, showing that they are the chief means of progress, and, as is the case with diving animals generally, are set as far back as possible. To all appearance they are totally different limbs from those which have just been mentioned, being curved, flat, and pointed, and looking more like oars than legs. Yet, if you will examine the leg joint by joint, with the aid of a magnifying glass, and compare it with that of any other insect, you will see that the same joints exist in each limb, though they are so greatly modified that their identity would scarcely be suspected by any one who was not acquainted with the anatomy of insects. They look, in fact, as different as the fore-leg of the horse and the wing of a bird, both of which members consist of the same elements 'differentiated' according to the office which they have to perform.

Here is another point to be noticed in connection with this pair of legs. Being used as oars, they need a broad, flat surface which can offer the required resistance to the water, corresponding to the blade of the oar. This object is attained in a very simple manner. The last joints of the leg are furnished with a row of stiff bristles, which are affixed at their bases in such a manner that when the leg is struck backwards the bristles project nearly at right angles, and form the blade of the living oar. But, when the insect throws the leg forwards in readiness for the next stroke, the bristles collapse, so as to offer the least possible resistance to the water. The

whole action is analogous to the 'feathering' of the oar as practised by our own oarsmen.

Now we turn to the prehensile legs, which are set as far forward as possible. These legs only attain their full development in the male. Three of the joints of the tarsus are greatly enlarged, and, if their lower surfaces be examined, a number of dark spots of different sizes will be seen upon them, two being very much larger than the others. The microscope reveals the extraordinary fact that each of these spots is a sucker exactly like those which are seen on the arms of the octopus. The two large suckers are set directly on the joint, but the others are set on foot-stalks, and look like wine-glasses with very long stems. This foot makes an admirable object for the microscope when preserved in Canada balsam.

Here I may say that if it should be absolutely necessary to kill a beetle, you can do so by dashing it into boiling water. You must make quite sure that the water is actually boiling, and will then find that death is so instantaneous that the insect has no time to suffer pain.

The tenacity with which these suckers maintain their hold is really wonderful. Some years ago I kept a male dyticus in a rather tall glass jar. He was fond of diving to the bottom of the jar when gorged with food, and clinging to the glass until obliged to rise to the surface in order to take in a fresh supply of air. One day it struck me that the beetle had remained below long after his usual time, and so I tapped the glass in order to arouse him. He did not move, so at last I took a long stick and pushed him with it, so as to 'poke

him up.' He certainly was poked up very effectually, for he immediately rose to the surface, but in several pieces. He had been dead for so long a time that decomposition had taken place, and the greater part of him ascended to the surface. But the first pair of legs adhered by means of their suckers to the glass, so that they and the whole of the prothorax retained their hold upon the smooth glass, the beetle having died without relaxing the muscle which caused the vacuum. .



GREAT WATER-BEETLE.

A somewhat similar result may be observed when two plates of glass are ground with absolutely true surfaces and are pressed together; even if there be nothing in the way of glue, they adhere so tightly together that it is almost impossible to separate them again without breaking

the glasses. Being ground absolutely true, there is no space for air between them, and in consequence the pressure of the atmosphere, which is about fifteen pounds to every square inch, holds them firmly against each other.

Next raise the wing-covers, and you will see beneath them a large pair of membraneous wings most beautifully folded. Try to refold them, and take notice of the beautiful hinges which enable the wings to be packed into so small a compass. The beetle is obliged to be furnished with the means of aerial locomotion for two reasons, one being its extreme voracity. It soon exhausts

the prey in one piece of water, and then flies off in search of another. Moreover, it has to seek its mate, and as its powers of locomotion on land are so imperfect, it is obliged to take to the air as a medium of transport. During the hours of light it remains in the water, where it reigns supreme, its coat of plate armour being a perfect defence against any foe that it is likely to meet in the brook. After dusk, the dytiscus takes to the wing, but is very seldom seen when flying, partly on account of the imperfect light, and partly on account of the height at which it flies. I have only seen one of these beetles in the air, and even that one could not be said to be on the wing.

When the dytiscus alights in the water, it does not settle on the bank and then crawl into the water, as the dipper does. Neither does it allow itself to sweep diagonally into the water, after the manner of the ducks. Instead of employing either of these plans, it flies on until it sees water below it, and then closes its wings and allows itself to fall like a stone. Many beetles meet with an untimely end in consequence of this habit. Their native instincts not being fitted to cope with civilized life, they often mistake the roofs of greenhouses for water, especially on moonlight nights, allow themselves to fall on the glass, and are consequently killed by the fall. One summer evening, when the moon was shining brightly, and a few light showers fell at intervals, I was standing at my garden door, when a small dark object shot downwards in front of me, fell upon the stone pavement, rebounded, and lay still. At first I thought that it was a stone flung by some mischievous boy, but on going to pick it up, found that it was a fine male dytiscus. The

insect had evidently mistaken the wet, flat, white stones for water, and had allowed itself to fall upon them. It is said that the roofs of the greenhouses are sometimes broken by the fallen beetles, and that the gardener very naturally thinks that stone-throwing boys have done the damage. Now, boys—who have been pronounced by competent authorities to be the natural enemies of the human race—are so justly accusable of every imaginable form of mischief, that I am glad to find one delinquency of which they are not guilty.

When the dytiscus dives, it is supplied with air after a sufficiently remarkable manner. Supposing that your specimen be dead, make a section of it transversely across the elytra. You will then see that there is a considerable blank space between the upper surface of the body and the elytra. As you may see by reference to the illustration, the spiracles, or breathing apertures, are on the upper surfaces of the edges of the abdomen, so that they are covered by the elytra, which fit water- and air-tight all round the edges, so that when the insect breathes the air which enters the spiracles must pass under the elytra. When, therefore, the beetle dives, it carries down a quantity of fresh air between the elytra and the body. This supply is quite enough to sustain life for some time, and when it is exhausted a fresh supply can be obtained in a very simple manner. The beetle allows itself to float to the surface, so that the end of the body is just out of water. It then expels the effete air, takes in a fresh supply, and again dives. The whole process of changing the air only occupies a few seconds.

If the beetle be kept under water when it is about to

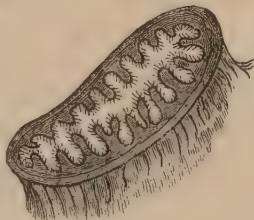


Foot of Water-beetle.

($\times 25$.)

rise to the surface, it will be drowned as effectually as if it were a human being.

As references must frequently be made to the spiracles of insects, I have made a sketch of the spiracle of the dyticus. The reader will see that the aperture is not continuous, as in that case extraneous matter might enter the air-tubes; so the entrance is doubly defended. In the first place, the aperture is of a labyrinthian pattern, so as to allow plenty of air to pass through it; and in the next the edges of the labyrinth are furnished with stiff, elastic bristles set at right angles to the edges, so that the air is, in fact, sifted before it can pass into the interior of the insect. The shape, size, and pattern of the spiracle differ in almost every species, but the principle is the same in all.



SPIRACLE OF DYTICUS.

Now we will pass to another stage of existence, in which the dyticus never leaves the water. This is the larval state, which is well represented in the illustration. The peculiar attitude of the body, which resembles the shape of the capital letter S, is characteristic of all these beetles, and is retained even after death, if they be preserved in spirits.

It is scarcely possible to sweep the net near the bed of the brook without capturing more than one example of the larva of the dyticus or some allied species.

Though, like the larva of the Gyrinus, it spends all its time in the water, it does not breathe by gills, but inhales atmospheric air through certain apertures at the end of

the body, as is shown in the smaller figure of the illustration; several insects breathe in similar fashion, especially in the larval state.

If you will examine the head of this larva, you will see that it is furnished with a pair of sickle-shaped jaws, so long that when they are closed their points are crossed, rendering it impossible for any prey to escape after it has been once seized. Yet, though the creature grasps the prey in these formidable jaws, it cannot eat the captured creature, but can only suck its juices. For this purpose the jaws are hollowed in a very elaborate fashion, a little oval aperture at the base of each jaw permitting the liquid food to pass into the mouth. The whole structure is very elaborate, but can be made out with a magnifying glass and a needle. The larva is so exceedingly voracious that it is almost impossible to keep more than one specimen in the same vessel, as they would certainly fight, and the stronger would kill and suck the blood of the weaker. Once, however, I did succeed in keeping five or six of these larvæ in the same vessel. I supplied them with pieces of raw meat, and it was wonderful to see how they would all fly at the piece of meat as soon as it was introduced into the vessel. With one accord they drove their curved jaws into it, and in a very short time sucked the whole of the juices from the meat, leaving it quite colourless.

I have noticed that whenever this larva seizes living prey, it always glides underneath it, raising it head upwards, so that the liquid food falls naturally into the throat. As with the larva, so it is with the perfect insect, only one specimen being admissible to the same vessel. It once happened that a fine male dyticus had been

captured and kept in a fresh-water aquarium. After a time, the owner took compassion upon the loneliness of the captive, and procured a female as a companion. A few hours afterwards he looked into the aquarium, hoping to enjoy the sight of their wedded happiness. But he could only find half of the male, he having been killed and half eaten by his disconsolate widow.

Being so voracious, the insect must of course be furnished with powerful organs of digestion. The gizzard, through which the food passes into the stomach, is armed with rows of most remarkable



STOMACH CELLS OF DYTICUS.



PART OF GIZZARD OF COCKROACH.

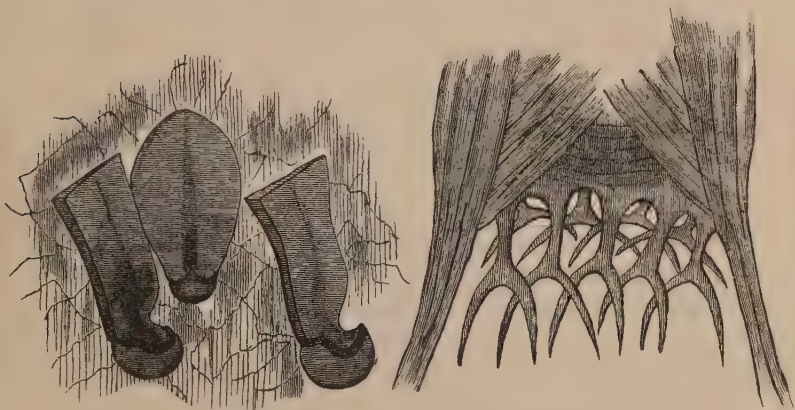
teeth, which are well worth the trouble of removal and examination under the microscope. But, beyond the gizzard, is another structure which, as far as I know, has never been described. The inner coat of the long, tubular stomach is covered with hexagonal cells, very much resembling those of the camel's stomach. They are so remarkable that I have had my drawing engraved expressly for this work. We shall presently see other examples of the marvellous care which the Creator has taken in order to complete the digestive apparatus of an insect. I would also draw attention to the fact that, whereas the handiwork of man becomes

coarse and rough in proportion to the magnifying power with which it is viewed, the work of God becomes more and more delicately beautiful as the magnifying power is increased. No better example can be found than in the gizzard of the common cockroach. This is an imported species, but there is a small grey cockroach which is often found on the banks of the brook, it being, in common with its relatives, a thirsty being. The gizzard is formed of six horny rounded lobes, much like those of a globular melon cut transversely and emptied. Each of these lobes contains a pair of horny jaws, and above them is a row of 'tooth-fans,' each being leaf-shaped, and, when examined by polarized light, having streaks of iridescent colour drawn at right angles to the central leaf-rib. These coloured streaks are seen, when examined by a power of two hundred diameters, to be, in fact, rows of crystalline teeth, each tooth-fan carrying on the average two hundred teeth. Thus, in the tiny gizzard of the despised cockroach there are twelve horny jaws, and an average of six thousand teeth!

When I was delivering the 'Lowell' lectures at Boston, Mass., U.S.A., in 1883-4, I mentioned and sketched this wonderful structure. After the lecture, one of the audience said that he should like to be a cockroach's dentist. So I had to inform him that it would be a very unprofitable post, because when the teeth were worn out the cockroach threw them off, swallowed them, and then made use of another perfect set which had been growing beneath the others.

The accompanying illustration shows one lobe of the gizzard of the cockroach. The large, horny jaws are seen below, and the five radiating tooth-fans above them.

In order to give some idea of the infinite variety with which the internal organs of nutrition are constructed, I here insert two illustrations of the gizzard apparatus of the dyticipidæ, both drawn by myself from actual specimens. The first represents three of the gizzard jaws of the *acilius*, a very common water-beetle, about half as large as the dytiscus, but almost identical in habits and structure. These jaws are arranged alternately in the gizzard membrane, as here shown, the



GIZZARD JAWS OF ACILIUS.

GIZZARD MUSCLES OF DYTICUS.

upper row being set directly on the membrane, and the lower row being set partially sideways. They are horny in texture, and of a dark reddish-brown colour. As these beetles are carnivorous and exceedingly voracious, the muscles which work the jaws must be extremely strong. The second illustration shows the muscles which work one of the six divisions of the dytiscus gizzard. I preferred the dytiscus to the acilius, on account of the greater size of the muscles, which, as

the reader will see, are not only powerful, but elaborate to the last degree.

There is one point about microscopic study that continually forces itself upon the observer. It is, that the wonders of the Creator's work are inexhaustible, and that the more powerful is the magnifying capability of the lens, the more perfect does the object appear. Each of these muscles is, as the reader may see, composed of a vast number of fibres lying parallel to each other. In



INSECT MUSCLE. PARTLY
TORN FIBRE.

order to show their structure, I here give a figure of a single fibre, which has been partially torn during the delicate operation of separating it from its fellows. Its beautiful and yet simple structure shows the mechanism by which a muscle contracts and expands; but having found the means we can go no further. It is true that the order to contract or expand is given to the muscles by means of nerves. But these again are only instruments, and no microscope can unveil the invisible power which acts through their means.

We have now nearly completed the life-history of the dyticus, but there is still one phase to be mentioned. Look at the lower left-hand corner of the illustration facing page 138, and you will see a grub very comfortably packed up in a hole in the ground. This is the pupa of the dyticus. When the larva has attained its full growth after some three years' residence in the water, it chooses a soft and muddy bank, forces its way into the soil, forms a large oval cell, and there lies motionless until the process of development is completed.

The Black Water-Beetle.—Although the dyticus is

popularly called the Great Water-beetle, it is exceeded in size by the Black Water-beetle (*Hydróphilus píceus*), the specific title being given on account of its pitchy black colour. It is more convex in shape than the dyticus, and does not possess the yellow edging which is so conspicuous in that insect. As it is a vegetarian, and does not attack its companions, it is in great favour with keepers of aquaria, and, indeed, some twenty years ago, when aquaria, both marine and fresh-water, were the fashion, there was such a demand for the hydrophilus, that it became quite scarce in the waters where it had once been plentiful. The streams and ditches about Cambridge were favourite hunting-grounds for aquarium keepers, who did their best to exterminate this fine insect, which is here represented of its natural size.

Except in its diet, the hydrophilus much resembles the dyticus, so that there is not much to say about it. Although, like the dyticus, it takes a supply of air with it when it dives, it renews the supply in a different manner. Instead of taking in the air at the end of the body, it places its head at the surface of the water, and, by means of the mobile antennæ, drives the air along the shoulders, if we may so call them, of the elytra, and so conveys it to the spiracles. These antennæ, by the way, are somewhat troublesome to those who wish to 'set' the insect after its death, the beetle having a way of tucking them so closely under the body that many specimens are seen in cabinets of beginners possessing apparently no antennæ at all, and only exhibiting the palpi. Both these organs are well shown in the illustration.

Strangely enough, the larva is just as voracious as

that of the dyticus, though after its change into the perfect form it abandons its carnivorous habits, and only feeds on vegetable substances. The upper figure in the illustration represents the female beetle clinging to a leaf of the common arrow-head and depositing her eggs. Although the eggs must be under water, they require air, and so the beetle is endowed with the power of reconciling these apparently opposite conditions. She deposits them on the under surface of some aquatic leaf, enveloping them in a watertight cocoon, and forming a sort of chimney or tube, through which the air can have access to the eggs. The number of eggs is very small, compared with the usual rule among insects, scarcely exceeding fifty. They are carefully fastened side by side in a manner which is not usual among insects. When hatched, the larva has a wide range of prey, even feeding upon the water-snails, whose shells and opercula are no protection to them.

The life of the hydrophilus larva is not nearly so long as that of the dyticus, seldom, if ever, extending into a second year. When 'full-fed' it, like that of the dyticus, leaves the water, burrows into the muddy bank, forms a rude cell, and there awaits its final change.

Besides these two giants among water-beetles, there is a host of smaller species, one of which, *Acilius* (it has no popular name), resembles the dyticus so closely in shape and habits, that those who are unacquainted with the fact that insects do not grow invariably mistake them for the young of that beetle.

BESIDE these insects, there are many water-beetles which, like the water-shrew and water-rat among the



The Black Water-beetle.

mammals, and the dipper among the birds, give no external indication of their aquatic habits. As they have no popular names, I am forced to employ the names by which they are known to entomologists. Taken generally, they are often known to boys by the collective title of 'squeakers,' because when removed from the water and laid on a smooth surface they spin round and round, emitting a squeaking sound, which is produced by the friction of their elytra. The beautiful musk-beetle (*Aromia*), of which we shall soon learn something, has a similar habit, as has the death-head moth.

Owing to our limited space, we can only find room for two of these creatures, and I have accordingly chosen two species which the brook-hunter is almost certain to capture at each sweep of the net.

Here is a much magnified figure of one of them. It belongs to the large genus *Haliphus*, of which there are



HALIPLUS FULVUS.



HYDROPORUS GRISEO-STRIATUS.

many species to be found in England. They are all little beetles, scarcely more than the sixth of an inch in length, yellow in colour, with oblong dark spots, as shown in the

illustration, exceedingly convex, and all so much alike that none but a practised coleopterist can distinguish between them. They are singularly hardy, as I have proved. Several specimens had been unintentionally introduced into the vessel in which I kept some fine larvæ of the dragon-fly. My nomad life preventing me from carrying on an unbroken watch over the inhabitants of my aquarium, it necessarily follows that they often die off just when I am beginning to hope that they may be successfully reared.

Accordingly, the dragon-flies, water-snails, caddis-grubs, and others all died, and I determined to leave the water to evaporate, so as to furnish good objects for the microscope. The *Halipli* entirely refused to succumb, and even when the water had well-nigh dried up, these little beetles were swimming about as actively as if they had been at liberty in their native brook.

A still smaller, and perhaps more plentiful genus is the *Hydroporus*, one species of which is here figured. To the collector it is one of the many aggravating insects with which all collectors are tormented, scarcely any two species of the same genus being noticeably distinct. Their general colour is dark brown, diversified with yellow spots. They are rather longer-bodied than the preceding genus, so that they may easily be distinguished as far as the genus goes. Unless you are well skilled in the Coleoptera, do not waste your time in attempting to distinguish species, but leave that task to a specialist, who will do for you in five minutes what you could hardly do in as many months, even if you possessed the voluminous literature on the subject.

CHAPTER XIII

DRAGON-FLIES, ETC.

Now we will take another set of creatures, which are quite as destructive as the water-beetles, and, if possible, even more interesting, especially in their larval state. These are the DRAGON-FLIES (*Libellulidæ*), which swarm about water, though they are seldom seen except in the summer months. There are many British species, but they may all be reduced to two types, such as are here shown. One set has the head rounded, while the head of the other is much wider than long, and is set crosswise on the neck, so that it looks very much like that of the hammer-headed shark. A type of each kind is here given. The larger is scientifically known as *Libellula depressa*, the specific name being given to it on account of its wide, flattened body, and may be seen even at considerable distances from water dashing after prey with a falcon-like flight. The other is called *Agrion puella*, the specific name, which signifies a girl, being given to it on account of its delicate beauty. The French know it as the Demoiselle. It may mostly be seen flitting over the brook, or perching on the reeds and sedges.

Altogether, there are nearly fifty British species of dragon-flies, so that their names and arrangement must

be obtained from some book on the subject, this treatise not being a work on entomology, but a general guide to the brook and its inmates.

Let us now watch one of these insects on the wing. Note the rapidity of its flight, which is even swifter than that of a swallow. Yet its wings do not seem to be so large in proportion to the body as might be expected from the manner in which the dragon-fly hurls itself



LIBELLULA DEPRESSA.

through the air. If the whole of the body were solid, the insect would not be able to pursue so long and so swift a flight. But its entire body is so permeated with air-tubes that its weight is quite inconsiderable, and the burden which the wings have to bear is but trifling. I believe that these are the only insects which can fly backwards as well as forwards. This faculty is especially useful when the insect which they are chasing takes refuge in a tree or bush. The long body of the dragon-fly prevents it from turning in the limited space between

the leaves, and it therefore is enabled to dart after its prey among the leaves, seize it, and back itself out again, without needing to turn. There is a well-known instance where a swallow had darted in chase of a dragon-fly into a large greenhouse. In spite of the limited space, the bird was quite unable to catch the insect, the power of reversing the flight having no little to do with the dragon-fly's success.

Several species of dragon-fly, especially those which belong to the genus

Sympetrum, have a habit of settling on pathways, and allowing themselves to be approached quite closely before they will move.

In the summer of 1886, while walking along a gravel path in a garden, I saw at least forty



AGRION PUELLA.

of these insects settling on the path. By way of curiosity, I tried to approach one of them, and by walking very slowly, not only approached it so closely that it was between my feet, but actually stooped over it so as to bring my eyes sufficiently near to discern the play of light in the eyes of the insect as it turned its head smartly from one side to the other in search of prey. It is worthy of notice that when the dragon-fly settles in this manner it remains still for a moment, and then suddenly throws both pairs of wings forward with

a jerk. In a newly dead specimen, the same movement may be exactly produced by pressing with the head of a pin on the middle of the upper surface of the thorax.

Several species have a habit which precisely resembles the well-known custom of the common fly-catcher. It perches itself on a branch or twig, or similar spot whence it can survey a wide prospect, and when it sees a passing insect on the wing, springs from the branch, darts after its prey, seizes it, and returns to its perch.

The voracity of the insect is almost incredible, and seems to lose none of its keenness even when it has suffered injuries which, in a being whose nervous system was more highly organised, would destroy every vestige of appetite. Not long before writing these lines I saw a fine specimen of the large flat-bodied dragon-fly called *Libellula depressa* hawking eagerly over a brook in search of prey. Yet it had sustained an injury so severe that it would have deprived any of the higher animals of the power of eating. The abdomen had been struck in such a manner that it hung downwards at right angles with the thorax. Yet the insect had lost none of its activity or its desire for food, and was prosecuting its search after prey with as ferocious zeal as if it had been wholly uninjured.

I know of a case where, in trying to capture a dragon-fly, the pursuer accidentally struck it with that part of the handle which crosses the middle of the net, and broke off the whole of the abdomen close to the thorax. Now, the abdomen contains the whole of the organs of digestion, including the stomach, and yet the mutilated creature was every wit as voracious as it was before its misfortune, and ate any number of flies and spiders,

although it had no stomach into which to put them. Most extraordinary of all, its captor, by way of bravado, offered to the insect its own severed abdomen, and was more than surprised to see it eaten.

Many other insects will act in the same wonderful manner, and it has long been known that the newly severed head of a wasp will eat flies or drink any sweet liquid, just as if it were still attached to the body. Even in much higher animals, a similar phenomenon has often been observed. In the diary of the late Frank Buckland, the writer, then a boy, mentions that the severed head of a newly killed turtle bit severely the hand of a kitchen-boy who handled it incautiously. One of my brothers, who was then in Brazil, killed a fine rattlesnake, and cut off its head, with the intention of sending it to me. He put the head into a box, took it home, and turned it out on a table close to a window. A dog happened to run past on the opposite side of the road, and my brother was astonished to see that the head had lost little of its vitality, the eyes noticing the dog, and the jaws opening, as if in defence.

Fish, too, are similarly unconscious of pain.

Take for example the remarkable experience of Mr. Cholmondely Pennell, the well-known authority on angling. He had caught a perch which was smaller than he could admit into his basket, and was about to return it to the water, when he saw that the hook had caught one of its eyes, and had torn it out of the socket. At first he thought that the kindest thing he could do was to kill the poor mutilated creature, but, as he said, 'knowing the reparative power of Nature in the fishes,' he threw it back into the water. Finding

that the eye was still on the hook, he out of curiosity dropped it into the water to see whether any fish would take it as a bait. It was hardly in the water, when the float was jerked under the surface. On pulling it up, he found a perch upon the hook, and, on taking it off, saw that it had just lost an eye. It was the identical fish which had just been returned to the water, and which had actually been caught with its own eye! Lord Lytton wove this story into one of his best novels.

Again, when sailors catch a shark, they always 'overhaul his locker,' in other words, cut the fish open, so as to see the nature of its last meal; some very remarkable revelations being often made. The whole of the interior of the fish being removed, the body is thrown overboard. The contact with the water seems to revive it, and it immediately follows the ship, in hope of procuring more food, although it has no stomach into which to put it.

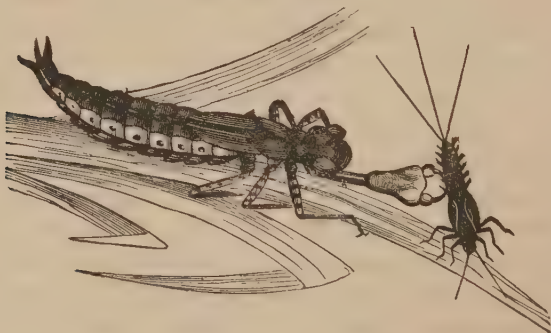
This leads us to another point—namely, the wonderful Providence by which no creature is gifted with senses that would be useless or even harmful to it. Judging, as we are naturally apt to do, other creatures by ourselves, we might think that the lives of the lower animals were embittered by constant pain. None of them die a natural death, according to our ideas of the word. They prey upon each other, and their natural death is to be eaten alive. Now, if they possessed the sense of pain or the fear of death as we do, their lives would indeed be wretched. But they are absolutely incapable of foreseeing or fearing death, and almost, if not quite, as incapable of feeling pain.

Even among human beings, sensitiveness to pain is exceedingly variable. The savage races, for example,

scarcely feel any pain from injuries which would have caused excruciating agony to a European ; the well-known endurance of the Red man at the stake being due much more to temperament than to moral power. Even among Europeans, and even in inhabitants of the same country, a similar difference in the capacity of bearing pain is to be found. Take, for example, the familiar story of Tom Brown. The hero of the tale comes of a full-blooded, hard-headed, tough-skinned race, always ready for a fight, and caring little for pain. Tom Brown treated a flogging with perfect equanimity, but would have suffered tortures if compelled to stay in-doors while his companions were at cricket, football, or the other athletic games in which his whole being delighted, and to produce an essay of a certain length during his period of imprisonment. The same treatment would have affected the sensitive, nervous, scholarly Arthur in an exactly opposite manner. The anticipation of a flogging would in itself have been a punishment far more severe than the actual birching would have been to his schoolfellow ; he would have felt the pain more keenly, and the remembrance would have filled him with shame which would almost have deprived him of his self-respect. For the prohibition to leave the house he would care nothing, while the essay which would have racked Tom Brown's brain into a headache would have been to Arthur but an intellectual amusement aiding him to pass the time until he was released.

I lay great stress on this subject of the distribution of senses, because it explains many apparent discrepancies in animal life, whether of man or of the creatures

occupying a lower plane of existence. Any history of the inhabitants of the water, whether fresh or salt, must largely consist of 'death and all its woes,' and show how the marine or aquatic animals can only sustain their own lives by taking those of other creatures, and by eating them alive. A superficial observer would naturally feel a difficulty in reconciling this incessant slaughter with the goodness of the Creator ; but a little more knowledge shows the utter futility of the objection, and proves that no more beneficent scheme could have been devised. Also, I wish to point out that we owe this knowledge to modern physiology, so that Science, instead of being opposed to Religion, is in fact her strengthener and exponent.



LARVA OF THE LIBELLULA SEIZING ITS PREY.

IN its larval life, which it passes in the water, the dragon-fly is, if possible, even more destructive than in its winged form. As is the case with the dytiscus, the larva is entirely unlike the perfect insect. As may be seen from the illustration, it is a soft-bodied, six-legged

grub, and appears anything but the formidable beast of prey which it really is, equalling the shark in voracity, and far surpassing the crocodile. The weapon by which it is enabled to work such slaughter is of a perfectly unique character, and is shown in action in the accompanying illustration. It is a modification of the very complicated mouth which is possessed by insects, the lower lip being very much elongated, and furnished at the end with two curved jaws much resembling those of the dyticus larva. It is, moreover, doubly hinged, so that when not in use it can be folded under the chin, the jaws being exactly opposite the true mouth.

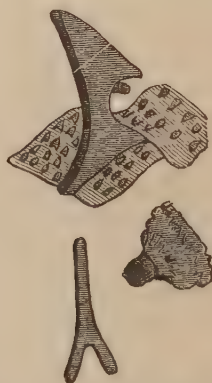
When this strange being seizes prey, it glides under the doomed insect, darts out the 'mask,' as this armed lip is called, grasps it in the jaws, and retracts the mask, so as to bring the prey to the mouth, where it is rapidly devoured. Should the insect be a large one and struggle to escape its fate, the first pair of legs are employed to hold it until it is too much injured to offer further resistance.

The larva being so voracious, we may naturally expect to find the gizzard-teeth largely developed. Such is the case, as you may see from the accompanying illustrations, which were drawn by myself with the aid of the microscope. The upper right-hand figure represents one of the gizzard-jaws and some of the gizzard-teeth as they appear *in situ*. Just below is a front view of the same jaw, showing its peculiar forking. On the left is a small portion of the membrane with ten teeth, and on the extreme right is a single tooth more highly magnified. As is the case with the acilius, the teeth are very hard, horny, and of a reddish-brown colour.

Here I will ask the reader to note that in speaking of the movements of the dragon-fly larva, I used the word 'glides.' This was done intentionally, as no other word can express the peculiar motion. I have kept many of them, and throughout the autumn of 1885 and nearly the whole of 1886 had several in a glass vessel on my table, hoping to see them make their final change into the winged form. I have watched them very carefully,



TEETH OF LIBELLULA
LARVA.



GIZZARD, JAWS, AND TEETH OF
LIBELLULA LARVA.

but never saw them vary their mode of attack. Without using the legs, they glide under their prey, as if moved solely by volition, without any perceptible effort, and then seize the insect with the mask-jaws, as has already been stated.

The mechanism by which the larva glides insidiously under its prey is one of the most beautiful structures in the wonderful world of insects. Like several other aquatic larvæ which have been noticed, the creature

breathes by means of gills ; but the gills, instead of being situated on the exterior of the body, are ranged along an internal tube extending nearly from the thorax to the extremity of the body, where it terminates in a small circular aperture, closed, or rather defended, by five little spikes, which can either be spread apart so as to disclose the opening, or can be pressed together so that they look like a single pointed spike. When they are thus closed, they effectually prevent any foreign substance from getting into the tube. If you make a section of the creature, you will see the gill-plates arranged in a double row, and looking like little greyish white folds of delicate skin. When the larva simply wants to breathe, it expands and contracts the body so as alternately to fill the tube with water and expel it, in order to keep the water flowing over the gills.

During this time it uses its legs like any other insect, crawling over the stones or among the plants. But, when it wishes to seize prey, it suddenly contracts the body, thus driving out the water with considerable violence. The reaction of the expelled water drives the body forward, just as a rocket is driven by the expelled gases formed by the combustion of gunpowder, and so the creature is enabled to dart swiftly through the water without moving a limb.

Should you wish to preserve one of these larvæ, you will find that if it be merely dried it will shrivel out of all shape, on account of the empty tube. You must therefore fill the tube with cotton wool, which can easily be done with the aid of a long pin ; and when the tube is quite full, the larva looks when dried just as symmetrical as it did during the life of the insect.

If you should ever hold the hose of a fire-engine while the water is playing, you will at first be scarcely able to retain your footing, the reaction of the water against the air being almost sufficient to throw a novice on his back, and the mode of action being precisely similar to that of the water-tube of the dragon-fly larva. Vessels have been constructed on this principle, water being expelled from two tubes, one on each side of the keel. By making these tubes turn on pivots, so as to direct the stream of water either backwards, forwards, or sideways, the vessel can be steered with sufficient accuracy to render it independent of a rudder.

The larva remains in the water for a considerable time, changing its skin frequently during the process of growth and development, but having scarcely any perceptible alteration of form. Indeed, except for the fact that the wing-cases become more prominent with every change of skin, there is little difference between the larva and pupa of the dragon-fly. The rejected skin is mostly left clinging to the object on which the creature had been standing, and looks exactly as if another larva had been placed in the vessel. Those who have kept crabs or shrimps in a marine aquarium must have noticed a similar phenomenon, two crabs appearing where only one had been previously seen.

When about to undergo its final change into the winged form, the pupa ascends the stem of some aquatic plant until it has crawled to some distance above the surface of the water. It then clings very tightly with its claws, gives a few convulsive movements of the body, and the skin splits along the upper part of the thorax, so that air can obtain access to the spiracles. For the

first time in its life it takes a deep respiration of air, causing its body to swell to such an extent that the rest of the skin gives way, and the perfect insect emerges, leaving the pupal skin still adherent to the stem on which it was clinging.

In order to show this process more clearly, the emerging insect is represented as bending backwards, as if feeling about for a foot-hold. I have never, however, seen this in actual Nature, the insect crawling up the



THE PERFECT LIBELLULA EMERGING.

stem, and so dragging itself out of its shed garment. On a favourable day plenty of these shed integuments may be seen clinging to the stems, their former inmates sporting in the air above them. The late Mrs. Gatty has based one of her most beautiful *Parables from Nature* on the transformations of the dragon-fly, under the title of 'Not lost, but gone before.'

As is the case with all winged insects, the wings, when the creature first emerges from the pupal shell, are thick, soft, and quite unfit for flight. I have already mentioned that every part of an insect is permeated with air-tubes.

Even the delicate flying wings are no exception to this rule. Indeed, the wings are not, as in the vertebrated animals, modified legs, but are additional organs, not jointed to the body like the legs, but attached to the upper surface of the thorax in a way peculiar to themselves. They are, in fact, developments of the respiratory system, and therefore consist chiefly of air-tubes inclosed between two very fine membranes, as is shown by the microscope. In order, therefore, to expand its wings, the insect suspends itself by its legs, so that the wings hang downwards in a current of air. It then keeps up a continual quivering movement, so as to shake the wings out of the folds into which they have been packed, and, by repeated respirations, drives the air through the innumerable tubes of which the wing is essentially constructed.

There is great luck in everything connected with the observation of Nature, and that luck generally falls to the lot of beginners. I know a venerable clergyman who took up the study of butterflies long after he was grey-headed. His first performance was the capture of six 'Bath Whites' in the road outside his own gates. I knew a little girl, aged ten, who began her entomological career by catching a 'Bath White' and a 'Crimson-speckled Footman'—a moth so rare that up to that time only a single specimen had been taken in England. She showed it to me just after it was killed, and it is now in the British Museum. Again, a friend of mine came up to me not long ago, and told me of a wonderful sight which he had witnessed. He had put some sticklebacks into an aquarium, and had seen the whole process of nest-making and watching over the young.

During a recent autumn I met a gentleman who asked me if I could explain the doings of an odd grub which he had caught in the water, and which, while he was looking at it, crawled up a stick, shook its wings, and flew away. He had been lucky enough to capture a pupa of the dragon-fly just as it was on the point of undergoing its final change. Yet careful observers have kept numbers of these creatures, and never had the luck to be present when they emerged from the pupa. So let all beginners rejoice, knowing that luck will be with them, and that they can never again hope for such chances as will fall to their lot at the beginning of their career.

You need not be afraid of handling any dragon-fly, and indeed there are very few British insects which can hurt you. It is true that their popular name among the rustics is 'Horse-stingers,' and that any average countryman believes that they were created for the express purpose of stinging either horses or human beings, just as he believes that the newt and the blindworm are venomous, and that the toad can spit fire. It is also true that the dragon-fly will, when captured, flourish its long body about in a most menacing manner, just as the common snake will dart its head at an enemy, as if it possessed a viper's fangs. But the dragon-fly can do no harm, and you can handle it as safely as if it were a house-fly.

CHAPTER XIV

WATER-BUGS AND WATER-SCORPIONS

As we are now looking down upon a slowly flowing part of the brook, we will wait a while, and note the habits of several insects which are only to be found in tolerably still waters, and have no love for the brook where it ripples and dances over the stones.

A group of some of these insects is here represented. Different as they seem to be, they all belong to the same order, and are indeed closely related to each other. Various names have been given to this order, but the leading entomologists of the present day have now agreed to call its members by the general title of *Rhynchóta*—i.e. beaked insects—because the parts of the mouth are modified into a sharply pointed beak, through which the insect can suck liquid food, whether it be animal or vegetable.

One large group of these insects inhabits the water, and its members are accordingly called *Hydrócores*, or Water-bugs. Those which are shown in the illustration can be found everywhere, and are singularly interesting in their structure and habits.

The Water-Boatman.—The central figure, which shows an insect swimming on its back, represents the



The Water-scorpion and Ranatra.

common Water-boatman (*Notonecta glauca*), of which an enlarged figure is given below, so as to show the upper surface and the bristly fringes of the legs, which answer the same purpose as the blade of an oar, and are, like those of the dytiscus, self-‘feathering.’ The name *Notonecta* is composed of two Greek words, which signify swimming on the back, and is given to the water-boatmen, of which there are many species, on account of their singular habit of turning on their backs when swimming. The rather peculiar form of the body accounts for this custom. If a transverse section were made through the centre of the insect, it would closely resemble that of a boat with its keel upwards. So, when the insect turns itself on its back, the boat seems to be righted with its keel downwards, and can be forced through the water much faster than if it were in a reversed position.



NOTONECTA
GLAUCA.

When the water-boatman is in repose it throws the two swimming legs forward, as shown in the illustration, so that in case of alarm its oars are laid out ready for the stroke that will carry it out of danger, just as in a boat-race the rowers lean forward when waiting for the signal to start, so that no time shall be wasted in making the first stroke.

Like all its kin, the water-boatman is a most predaceous being, chasing other insects with the help of its oar-like legs, and then driving its beak into them and sucking their blood. In one genus of water-boatman called *Naucoris*, and easily distinguishable by its wide

and flattened body, the beak is sharp and strong enough to pierce the human skin and to inflict a rather painful wound. The naucoris swarms in Swindon Reservoir, and there I first learned practically that the insect can use its beak to some purpose as an offensive weapon. I had taken a number of the insects in the net, and was holding one of them in my fingers for examination, when I felt a sharp pang dart through my finger. Not suspecting the cause, I retained my hold, and was rewarded by another stab. I believe that some poisonous secretion is carried into the wound, for I suffered for some hours from a dull, aching pain, which seemed to penetrate to the bone. Even the common water-boatman can use its beak rather smartly, but I have never suffered from its weapon nearly as much pain as was caused by the naucoris.

Upon this beak the water-boatman impales its prey, clasping it tightly in its first pair of legs. It retains its hold with wonderful tenacity, and swims about the water holding its prey tightly in its grasp. On an average, it occupies about a quarter of an hour in sucking an insect dry, and no sooner has it done so than it drops the useless carcase, and goes off in search of another.

When at rest the water-boatman likes to hang head downwards at the surface of the water, breathing in much the same fashion as has been narrated of the dyticus. Owing, however, to the comparative transparency of the elytra, the course which is taken by the air is perfectly visible. It enters the space between the elytra and the body, and works its way sinuously to the shoulders, where it makes its escape in the form of little bubbles, which rise continually to the surface.

While hanging in this quiet way, it takes the opportunity to make its toilet, no cat being more fastidious about personal cleanliness than is the water-boatman. It uses its feet very much as pussy does, and does not leave the smallest portion of its body untouched.

It has another and perhaps a more remarkable mode of taking rest. It appears to crouch upon the surface of the water, supporting itself on its outstretched legs. While so doing it opens its elytra, half spreads its wings, and is evidently enjoying a sun-bath. I have often seen the insects when crouched on the water, but never knew them do so unless the sun was shining upon them. I have often, when in the Zoological Gardens on a hot summer day, seen the vultures crouching on the ground and engaged in sunning themselves, the whole attitude being almost exactly like that of the water-boatman.

The wings are very ample, and, like the whirligig beetle, the water-boatman can take to flight from the surface of the water; a feat which I have often seen it perform. When in the air it produces a deep humming sound that might almost be mistaken for that of the humble-bee.

Its return to the water after it has been in the air for some time is very ludicrous. The body and limbs are quite dry, and when the insect tries to dive it is hindered from forcing its way below the surface by the large quantity of air which becomes entangled among the hairs of its body and legs, and makes it look as if it were covered with little beads of polished silver.

It is almost impossible to pass the net through the water without inclosing within it a number of insects

which are generally mistaken for the young of the water-boatman. A closer examination, however, will show that they belong to a different genus. Their bodies are straight-sided, and flattened above, instead of being keeled, like those of the water-boatman. Their bodies being thus flattened, there is no need for them to swim on their backs, and accordingly we find that they swim like most aquatic insects, with their backs upwards.

These insects belong to the genus *Corixa*, of which there are many species.



CORIXA STRIATA.

In this country the *Corixæ* are exceedingly plentiful, but in some of the fresh waters of South America they swarm to such an extent that their eggs are collected, pressed into cakes, and used as food.

When they take in a fresh supply of air, the *Corixæ* do not receive it at the end of the body, but at the junction of the head with the thorax. The head is exceedingly mobile, and by bending it forwards the insect forms a channel into which the air passes, and is then directed over the spiracles, the movement being so rapid as almost to elude observation.

The Water-Scorpion.—Examine carefully the banks of the brook, and you will almost certainly discover the very remarkable insect which is shown on the right hand of the illustration (facing page 170), and is popularly known as the Water-scorpion, on account of the very singular first pair of legs and the long, projecting filaments of the tail. Its scientific name is *Nepa cineræa*,

the specific name, which signifies ashen, being given to it on account of its dark colour. Flatness is the leading characteristic of this insect, which really looks as if it had been crushed under a heavy weight. In colour it closely resembles a withered oak leaf, and it is nearly as flat, so that it mostly escapes observation. I have frequently been told that it was not an inhabitant of certain waters, and yet found it in plenty within a few minutes.

The fact is, that its movements are always slow and deliberate, so that even if it were to make a step with one of its legs the limb would probably be taken for a loose fibre floating in the water. Moreover, it is mostly so covered with mud that its form can scarcely be distinguished, even by the most practised eye. For this immunity from detection it is largely indebted to its structure.

Although there is little external connection between the first pair of legs and the long, straight tail-spike, neither organ would be of much use without the other. When the water-scorpion is immersed, the tail-spike looks like a single piece. But it is in reality composed of two pieces, which are slightly grooved on the inside, so that when they are pressed against each other they form a tube. This tube is intended primarily for the conveyance of air to the spiracles, and is used in the following manner.

As is the case with the other Hydrocores, the water-scorpion is carnivorous, and lives by sucking the blood of other insects, most of them being aquatic, and very much more active than itself. Accordingly, it employs a stratagem much resembling that of the well-known

ant-lion. It buries itself almost wholly in the mud, its first pair of legs projecting in front, and only the tip of the tail-tube being above the surface of the mud behind, so that all indications of its presence are effaced, the legs being held motionless, and the tip of the tail-tube being so small as to be practically invisible. As soon as a luckless insect comes within reach of the prehensile legs, it is firmly grasped and then dragged upon the beak, through which its juices are quickly sucked.

My son, Theodore Wood, whose entomological proclivities are pretty well known, was lately sitting on a bank, watching the inhabitants of the water, when he saw a fly descend and settle upon the muddy bank, some inches from the water. No sooner had it settled than it sank beneath the mud, its struggles exciting the observer's attention. On removing it from the mud, he found that it had become the prey of a water-scorpion which was buried in the mud, and had seized the fly as soon as it settled.

You are tolerably sure to capture several of these insects if you will scrape your net well along the muddy banks. Take the finest of them, and examine it as a specimen. This you are quite justified in doing, as long as you do not inflict needless pain ; and, as I have shown, the sense of pain is almost non-existent in insects. No true naturalist ever kills any creature without an object, and carries out Cowper's familiar and just denunciation of those who would needlessly tread upon a worm—a denunciation which has the more force because Cowper did not know that the worm cannot suffer pain in our sense of the word, and that if it had not been for the work

of the earthworm man could have found no place on the earth.

So, take a fine specimen, and dash it into boiling water, as already mentioned. Dry it on blotting-paper, and examine its upper surface while it is still fresh and flexible. Flat as the insect is, you will find that along the centre of the body there runs an almost cylindrical ridge, which on examination will be seen to contain the vital organs. On either side of this central ridge, and almost covering it, is a flat brown elytron or wing-case. Lift them with a pin or needle, draw them out until they are at right angles with the body, and fasten them in in that position. Below them will be seen a pair of membranous wings. Spread and fasten them in like manner, and you will be surprised to see how completely the aspect of the insect is altered. Indeed, were it not for the tail-spike and the prehensile front legs it could hardly be recognised as the same insect, especially as the upper surface of the body is a bright red.

The voracity of the insect is very great, as may be seen from the fact that my son put a piece of raw mutton into the vessel in which he was keeping a water-scorpion. The insect seized the meat in its fore-legs as if it had been an insect, drove its beak into it, and for seven consecutive hours held the meat in its grasp. In the same vessel were many other insects, on which it would have fed if no other nourishment had been supplied. But it recognised at once the superior quality of the meat, and so the intended victims were allowed to swim about in peace and safety.

Like other insects of the same order, it retains nearly the same shape throughout its lifetime, excepting that in

the larval state the wings are not developed, and the tail-spike is very small.

Perhaps the most extraordinary point in the life-history of this insect is the mode of depositing its eggs. We are mostly accustomed to consider eggs as smooth objects, more or less oval in shape, and few persons are aware that many insects' eggs are covered with beautifully sculptured patterns, while several have their surfaces furnished with spikes. But the egg of the water-scorpion surpasses them all, for not only is its upper portion furnished with seven long spikes or arms, but those arms are movable under the action of moisture, and for the following reasons.

The larva of the water-scorpion being aquatic, it is necessary that the young creature, as soon as it is hatched, shall find itself in the water. But the egg requires the influence of air and the warmth of the sun's rays before the inmate can be developed, so that if it were totally submerged it could not be hatched. Taught, therefore, by instinct, the mother insect goes to the upper surface of some floating leaf—mostly that of the water-lily—and bores a hole through it. Into this hole it introduces an egg. Now, when first laid, the arms of the egg are all pressed together, so as to take up as little space as possible. If the form of the egg remained unaltered, there would be a likelihood of the egg falling into the water, where it would perish. But as soon as the water touches the bases of the arms they begin to separate, and then curl over, so that they effectually prevent the egg from falling into the water, while at the same time they ensure the needful influences of warmth and air.

I have already stated that the water-lily leaf is a favourite with this insect. Yet the finding of the eggs is very much a matter of luck. You may examine a hundred leaves most carefully, and not find a single egg, while it is possible that the very first leaf may contain twenty or more eggs.

CHAPTER XV

RANATRA, ETC.

ON the left-hand of the illustration facing page 170 may be seen an insect, which, although it is so different in general aspect from the water-scorpion, is closely related to it. Though it is plentiful all over England, it is very little known, owing to its form and peculiar habits. It has, therefore, no popular name, and I must perforce call it by its scientific title of *Ranatra*.

Just as the water-scorpion runs to width, the ranatra runs to length, its body and limbs looking as if they had passed through a wire-drawing machine. If possible, it is even slower in its movements than the preceding insect, so that in catching prey it is obliged to wait until an unsuspected victim comes within reach. It does not, however, hide itself under mud, but disguises itself quite as effectually in a different manner. Stretching the second and third pairs of legs among the stems of the water-plants, it holds the first pair of legs aloft. While in this attitude it scarcely looks like an insect, the long and slender limbs having exactly the appearance of loose fibres which have become entangled among the weeds. I once kept a ranatra for a considerable time, and on several occasions when showing it to my friends have

found that they were unable to distinguish it from the water-plants to which it was clinging.

If alarmed, it assumes a still more extraordinary attitude. It stretches out its legs in a line with the body, pressing them closely together, and looking like anything but an insect. Even experienced entomologists are sometimes deceived by the changed aspect of the insect. On one occasion my son, whose speciality is beetles, was hunting for water-beetles, and was investigating the 'take' of his net, throwing aside the bits of stick, straw, caddis cases, etc., etc., with which a net is always encumbered. After taking out the beetles, he happened to be looking at the *débris*, when he saw one of the rejected pieces of stick thrust out a long slender leg. Being attracted by this phenomenon, he again picked up the seeming stick, and found that it was a ranatra with its legs stretched out. So the insect had twice deceived its captor, who had not only looked at it without detecting its true character, but had actually handled it without distinguishing it from a stick.

The first of these attitudes is that in which it awaits prey. No sooner does an unlucky insect come within reach, than the two front legs are struck at it with a movement too rapid for the eye to follow, and the victim is clasped in the folding joints, which shut down just like the blades of a pocket-knife. Even fish are caught in these terrible instruments of prehension. No sooner is the prey taken, than it is dragged upon the beak, through which the blood is soon sucked, as has been narrated of the water-scorpion.

Seen in either of these attitudes, it gives but little idea that it is one of the insects which can fly. Yet a close

inspection will show that a pair of long and narrow elytra extend along the body, protecting a pair of ample membranous wings, by means of which it can make its way from one piece of water to another.

It is a singularly bold and fierce insect, and will attack any creature which comes within range of its stroke. If you put your finger near it, the insect will strike at the intruder, and it is really astonishing to realise the muscular power which is concentrated in those slender limbs.

I have already mentioned that this singular insect has no popular name, although I have tried to find one which might be generally accepted. Some years ago, a young lady asked me whether I knew that the 'daddy-long-legs' lived in water. She said that she had caught one in a brook, and that she had it at home in her aquarium. Of course, the insect was a ranatra, and, as she called him 'daddy,' it occurred to me that the name 'water-daddy' might be found both appropriate and convenient.

Its united strength and ferocity are well shown in a letter written to *The Entomologist* by Mrs. A. G. Laker.

A ranatra was in the same vessel with some sticklebacks. Now, the stickleback is a fish which is very well able to take care of itself, and is indeed of an aggressive character. Yet the ranatra seized in its grasp a stickleback an inch in length, and held to its prey so firmly that it allowed itself to be lifted out of the water without loosening its grasp. The stickleback was then forcibly removed, and the ranatra restored to the water. Afterwards, the stickleback was replaced in the aquarium, and was immediately seized afresh by the ranatra, which was then allowed to complete its meal in peace.

It will even attack the round-bodied, hard-skinned water-beetles, turning and twisting them about until it finds some crevice into which it can thrust its beak.

Now let us watch the surface of the water. Skimming over it with marvellous rapidity are the active and rather long-legged insects which are popularly called water-fleas, on account of their jerking fashion of progression. The name, however, is a faulty one, because it rightly belongs to some little crustaceans belonging to the Entomostraca (*Daphnia*).

These insects, of which there are many species, belong to the genus *Gerris*, and are well worthy of notice. You will see plenty of them leaping, as it were, over the surface of the water. Make a sweep at them with your net, and see how many you can take at a single stroke. The chances are that not a single gerris is in the net, for their wariness is on a par with their activity. You must be thoroughly versed in the ways of the gerris before you can be fairly sure of capturing it. Supposing that you have caught one of the commonest species (*Gerris lacustris*), you ought to examine it carefully, and, if possible, with the aid of a magnifying glass.

First, note the manner in which the legs are attached to the body. In most insects they are jointed to the under surface of the thorax, but in the gerris they are attached to projections upon the sides, so as to obtain a wider grasp of the water. In fact, they remind the observer of the outrigger of a racing boat. Should your specimen be adult, it will probably possess elytra and wings very much like those of the preceding insect.

Note the word 'probably.' In almost all winged

insects, the perfect state is known by the attainment of the wings. But in the gerris, as in a few other insects, the perfect state can be reached without the development of wings, so that to all external appearance it is nothing but a larva. The sense of touch, however, serves to correct that of sight, and we can without difficulty distinguish the still imperfect insect by the softness of its body, the perfect insect, whether winged or not, being hard-bodied.

Sometimes, while examining these insects, we shall find some small specimens which look exactly as if they had lost the whole of the abdomen. A closer inspection, however, shows that a very tiny and sharply pointed abdomen is to be seen, but so small that it scarcely seems capable of supplying sufficient digestive power for maintaining life. This is the more remarkable because these apparently mutilated organs belong to the larva, whose duty it is to assimilate as much nourishment as possible, that of development being left to the pupal stage of existence. I well remember my exceeding bewilderment when I first took specimens of these eccentric larvæ, not in the least knowing how to class them.

Now, turn your specimen on its back, and note the dense clothing of short silken hairs with which the under surface is covered, and which enables the insect to glide over the surface of the water with the peculiar jerking movements which have been mentioned. Also note the long, jointed beak, which is folded under the head until wanted, and which is used, like that of the preceding insects, for sucking the blood of the prey.

The gerris can leave the water at will and make its

way upon land, and indeed has been found at a considerable distance from any water. Still, the land is not a familiar element to the gerris, and if attacked when on land it always makes its way to the water as fast as possible.

THESE insects are conspicuous enough ; but what is that dark shadow which seems to be blown over the water without any exertion of its own ?

Look at it closely, and you will see that it is an insect even more attenuated than the ranatra. Its body is hardly larger than a lady's needle, and the legs and antennæ are scarcely thicker than hairs. Even in a large specimen, measuring half an inch in length, the extreme width of the body is barely the twenty-fourth part of an inch. Yet even within that narrow compass a pair of membranous wings are packed under their elytra.

Perhaps you may have seen the wonderful 'walking-stick' insects of the warm regions, and, if so, must have been struck with the singular resemblance between them and the *hydrometra*, as this insect is



HYDROMETRA STAGNORUM.

called. The name is a very appropriate one, and signifies water-measurer ; in fact, it looks like a short black needle supported on six hairs, two more hairs projecting in front, these being the antennæ. It does not skip on the water by fits and starts, like the preceding insect, but glides smoothly over the surface, as if impelled by volition rather than by its limbs.

Slight as it may be, it is one of the predaceous denizens of the water, catching with the first pair of legs any fly or other insect that may happen to fall into the water.

I well remember when, being at the time a very young boy, I was an eye-witness of the insect's character. I was watching the surface of the river, when I saw a fly passing over the water in a very mysterious fashion. It was about a quarter of an inch from the surface, and yet did not appear to be using its wings. On approaching closer, I saw that the fly was upheld in the slender front legs of a hydrometra, which was making its way to shore with its prey.

I believe that the hydrometra seldom hunts for prey any distance from shore, mostly being within a yard or so of the bank. Owing to this habit of clinging to the bank, and its comparatively slow movements, there is not much difficulty in catching the hydrometra, providing you can see it. But the surest mode of capturing this almost invisible creature is, to draw the net smartly over the surface of the water in some sheltered spot, keeping the net close to the bank; and the chances are that you will find several hydrometras in the net, though you did not see them in the water.

It is extremely difficult to distinguish the several species. Size is of little help, as these insects retain their form through the whole of their lives. Moreover, as some of them share with the gerris the remarkable property of attaining their perfect form and yet remaining wingless, the difficulty is more than doubled. I have therefore selected only two of the commonest species as types of the entire group.

IN company with the gerris and hydrometra may be seen a number of small insects, which are generally mistaken for the young gerris, but which belong to the genus *Velia*, and can readily be distinguished by the great comparative breadth of their shoulders. Very few of them are winged, the generality of them retaining the permanently wingless form which has already been described. Their movements, too, are quite unlike those of the preceding insects. They do not jerk themselves over the water by fits and starts, like the gerris, nor drift, like the hydrometra. They are as restless as the whirligig beetles, their legs hardly ever needing repose. The insect is familiar to anglers by the name of water-cricket.

CHAPTER XVI

THE SEDGES AND BROOK BANKS, AND THEIR INHABITANTS

CONTINUALLY looking into water is apt to strain the eyes, so we will relieve the strain by investigating the leaves and stems of the aquatic plants, and searching for any insects which may be upon them.

At first it will be as difficult to detect them as it was to espy the insects beneath the surface of the water. By degrees, however, the eye becomes trained to its new task, and plenty of insects are visible where at first the plants seemed to be absolutely devoid of animal life.

The insects are mostly, though not always, more or less of a green hue, which will partly account for their invisibility. Moreover, none of them are large, and they very seldom betray themselves by moving, preferring to cling motionless to the plant. Seeing them, however, is one thing, and catching them is another, for they easily take alarm, and when frightened allow themselves to drop, either into the water, or among the dense herbage of the bank, where it will be useless to hunt for them.

So you must for the nonce convert your water-net into a sweep-net, handling it very delicately, for fear of

tearing the net. Place the edge of the net very cautiously against the stem of the plant, and as low down as possible, taking care not to jar the plant, as if you should do so the insects will let themselves drop and evade the net. Then sweep the net smartly upwards, press it against the stem, and you will probably capture several of the denizens of the plant. Some little knack is required for a successful sweep, but it is soon acquired, and in a little while you will become so expert that scarcely a single insect will escape.

Weevils.—The insects which you will capture will mostly belong to the beetle tribes, and, as a matter of course, many of them, and probably the greater proportion, will be Weevils, the most plentiful and the most generally present of all the beetles. Indeed, I never remember making a single stroke with a sweep-net without finding several weevils within it.

The weevils are known by their extremely long snouts, which in some species are so long and slender that they look more like curved bristles than heads of insects. As the antennæ are situated near the end of the snout, the insect presents a singular, not to say grotesque appearance.

A very beautiful British species is the Bacchus Weevil (*Rhynchites Bacchus*).

It is about one-sixth of an inch in total length, and when seen by the unaided eye simply appears to be an ordinary coppery red beetle. But when placed under the microscope, it, as is the case with most weevils, shows itself to be an insect of singular beauty. Perhaps I may be allowed to quote my own description of it in *Insects at Home*.

‘This species is certainly not the least handsome among its splendid brethren, its colour being a rich red, almost coppery gold, on which is a long soft down. The thorax is deeply punctured, and the elytra, which are rounded at their tips, and rather separated from each other, are as of burnished copper, sometimes taking a purplish hue. Their surface is covered with very deep and bold punctures, and with a vast number of wrinkles running transversely against them. There is much variation in the colouring of this splendid beetle, which is sometimes greenish and sometimes blue, but, as is the case with many of such beetles, the exact hue depends very much on the angle at which the light is reflected from them to the eye, green changing to blue, then to purple, and purple to gold, as the insect is turned to the one side or the other.’

It is a very rare insect, but has once been found in some plenty on the common blackthorn, a bush which is often seen on the margin of our brooks.

The typical English weevil is the Nut Weevil (*Balaninus nucum*), an insect which many people, especially in their young days, have had good cause to dislike. The bitter-tasting and evil-smelling nut with which we are only too familiar derives its repulsive qualities from the larva of this weevil. Before the nut is fully formed, the mother weevil bores a tiny hole at its base, and inserts a single egg into the wound. Presently, the egg is hatched into a little white grub, which grows rapidly, and as it grows eats its way through the substance of the nut, never destroying the germ.

It is a remarkable fact that, although until the grub

is full fed and makes its way out of the nut there are no external traces of the inmate, the squirrel has some means of discovering its presence, a worm-eaten nut never being found in a squirrel's store-house.

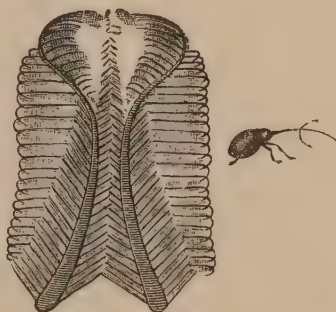
The very repulsive odour and flavour of 'corked' wine, which much resemble those of the worm-eaten nut, are produced by a tiny beetle of the weevil tribe, the larva of which feeds on cork.

Some of the smaller species inhabit wheat-grains and other cereals, and often do terrible damage to the stored grain. They are so small that ten thousand of them only weigh one ounce, and yet they are so numerous that a ton and threequarters weight have been sifted out of a granary at a single operation.

Then, as sailors know to their cost, even at the present day, there are weevils which feed on biscuit, and make it nearly as noisome as a worm-eaten nut.

The nut weevil being our type of the group, I give here a figure of it. Note the very tiny mouth of the insect, which is necessarily a small eater, and therefore does not require its gizzard teeth to be so powerful as those which have already been described.

Here is a drawing made by myself of the insect and one lobe of the gizzard. The jaws and teeth are so altered in shape and general appearance as scarcely to be recognizable.



NUT WEEVIL AND LOBE OF THE
GIZZARD.

The two jaws, however, can be seen in the middle. They are greatly elongated, taper gradually towards their tips, and then curve gracefully inwards until they nearly meet. On either side of the jaws are the long and slender teeth, arranged in the remarkable manner which is here shown.

The jaws are dark brown, while the teeth are of a translucent yellow, so that the organ presents a singularly beautiful aspect.

Some of the foreign species are well known in England by means of books of travels. One of them is the great weevil belonging to the genus *Calandra*, which is the parent of the celebrated palm grub, sometimes called the Gru-gru. This grub is white, fat, and about as large as a man's middle finger. It is a West Indian insect, and the nerves of new-comers are sometimes rather rudely shocked when a dish full of gru-grus is brought to table as a delicacy. Those who are initiated into the ways of the country take the gru-gru by the horny head, put the body into the mouth, and nip it off as if it were a strawberry.

Another is the equally celebrated diamond beetle, an insect rather larger than a cockchafer, whose body is adorned with scales which in brilliancy and vivid colouring equal, if they do not surpass, the feathers of the humming bird's throat. Set as microscopic objects, these scales are extremely popular, and command a large sale.

Now, none of our British weevils are large enough to be utilised as food, even if we could overcome our insular prejudices. But in point of gorgeous brilliancy the little dull-green weevils which you will capture in your net do

not in the least yield to the more imposing weevils of the tropics.

Size in science is of no consideration, the microscope making a cheese-mite as easy of investigation as if it were an elephant. Under a moderately high power, say from one hundred and fifty to two hundred diameters, the scales which clothe our little weevils are just as magnificent as those which are found upon the diamond beetle of the West Indies. Some of them even surpass the insect in the sculpturing of the elytra, which are decorated with patterns so elaborate and so beautiful that I have often wondered why goldsmiths and other art-workers have not embodied them in the precious metals.

Should you possess a microscope, I strongly recommend you to put up several specimens of these wonderful scales. Then, should you possess a keen eye and delicate touch, I also recommend you to open the insect, take out the gizzard, and submit it to the microscope. This is not so difficult a task as might be imagined. Break the insect asunder at the junction of the head and thorax, and just inside the abdomen you will see a little round knob. This is the gizzard. Open it, spread it flat, and you will see six rows of slender teeth, arranged as shown in the figure.

Even after the insect has been for years in a cabinet, the gizzard can be removed without injuring the specimen. On breaking it asunder, the gizzard will be plainly visible, and can be taken out with a needle. A touch of cement will enable the severed portions of the insect to be re-joined, and it can again take its place in the cabinet without showing any signs of the junction. 'Putting'

up the gizzard in Canada balsam as an object for the microscope is an art easily learned, but not coming within the scope of the present work.

MOSTLY upon the leaves of the sedges and similar water-plants will be found some small, straight-sided, hard-bodied beetles, shining with a peculiar silken lustre, and having extremely wide heads and shoulders. They have no popular name, and so I must make use of their scientific title, *Donacia*. This is a very appropriate generic name, being formed from the Greek word *Donax*—*i.e.* reed.

Nineteen species of this very beautiful genus inhabit England, but very few insects are more variable both in size and colour. Metallic green is the prevailing hue, 'shot' more or less with coppery reflections, and it is possible to procure a dozen specimens of the same species which shall exhibit every transition of colour from pure green to copper.

Although they can cling with extreme tenacity to any object on which they may be standing, they, like many of the weevil group, have the exasperating habit of letting themselves drop as soon as the fingers approach them. Living as they do on aquatic plants, they naturally fall into the water. However, they are good swimmers, and speedily make their way to the nearest water-plant, and then place themselves again in safety.

If you can manage to cut some of the sedges below the water-line, and will examine the under surface of the leaves, you will probably see some oval and rather elongated objects, looking much like accidental splashes of mud. It is evident, however, that such splashes could

not have been made naturally, as in a brook or on its banks there are no creatures which are in the habit of throwing mud about. Open one of these objects, and you will find that the mud conceals a small cocoon, which is nearly certain to be made by the larva of some species of donacia.

In point of structure and material, the cocoon of the whirligig beetle is very similar to that of the donacia; but the latter can always be known by its greater length.

There are very many other beetles to be found in the same localities, but for the present we pass to larger and more important beings.

CHAPTER XVII

BATRACHIANS

I WONDER how many people could define the distinction between a frog and a toad, if suddenly called upon to do so. I wonder how many people understand the relationship between the frogs, toads, and newts. I doubt whether one in a thousand could answer these questions. As a rule, young girls seem to think that they are exhibiting enviable refinement when they start and scream at the sight of a frog, toad, or newt, and class them all under the denomination of 'horrid things.'

To such a degree is this prejudice carried, even among the presumably stronger sex, that I have known an exceptionally powerful young man to be frightened almost out of his senses, because a newt, or, as he called it, 'a fish with legs,' happened to run across the path in front of him. He was not lacking in courage, and I really believe that if an angry bull had met him he would have faced the animal without a failing heart. But the sight of such a terrible creature as a fish with legs was too much for him.

Now, I do not lay the entire blame of such folly on its victims, but on the shoulders of those who instilled into the minds of the young who were intrusted to their care the idea that everything that crawls is noxious. I need

hardly say that none of my own children have felt the least fear of any living thing that shares the earth with them. Of course, they learned to recognize those creatures which are really hurtful, and would not attempt to pick up a viper, or to catch a wasp or hive-bee in their hands. But they would have no hesitation in taking up a grass-snake, or in catching the 'drone-fly,' which almost exactly resembles a bee, or the yellow-bodied, black-banded syrphus fly, which closely simulates the wasp. In the course of this work I shall again allude to this subject.

WHAT are the three creatures which I have classed together? Until lately, they were classed among the reptiles, but are now placed in a separate group called Batrachians, from the Greek word *Batrachos*—i.e. a frog.

The batrachians differ from the true reptiles in many important respects. In the first place, their bodies are not defended by scales, as in the serpents, by bony plates, as in the tortoises and turtles, or by more or less horny developments of the skin, as in the crocodiles and other lizards. The skin of the batrachians is always bare, and is so porous that it absorbs or gives out moisture with great rapidity, and can even absorb air for the purpose of aiding the natural respiration.

The most important distinction, however, lies in their development, the batrachia passing their earlier stages of existence in the water, breathing by gills, so that they practically live the life of fishes, and gradually exchanging their external gills for internal lungs as they approach the perfect state. In fact, the caterpillar and the butterfly are not more unlike each other than are

the young and adult batrachians. We will now trace the life-history of a batrachian from the egg to the adult being.

It is necessary first to mention that the batrachians fall naturally into two divisions—*i.e.* those which retain their swimming-tails throughout life, like the newts and salamanders, and those which lose their tails on attaining maturity, like frogs and toads. In the earlier stages of existence, the young batrachians so closely resemble each other that it is impossible to discriminate between them, and, as we shall presently see, the distinction is scarcely perceptible until development has made some progress.

Suppose that we begin with the egg of the frog.

In the spring almost every pond and most of the sluggish portions of our brooks will be found to contain certain masses of jelly-like matter, in which are numbers of black specks, distributed with tolerable equality. Some of these jelly masses are so large that an ordinary pail can scarcely contain them. They are popularly known as 'frog-spawn,' and are in fact the eggs of the common frog.

Now, if each mass were the joint production of a number of frogs, its size would be no matter of wonder. But when we are told that each mass is produced by a single frog, the statement seems incredible, so small is the frog in proportion to the mass of eggs. Of course, if the eggs when laid were as large as they are when found in the brook, it would be absolutely impossible for the frog to produce them. But when laid they are exceedingly small, being, in fact, the black specks which have already been mentioned.

Take a piece of egg-mass, and examine it closely. You will then see that the eggs are not scattered at random in the mass, but that each is encased in a transparent cell of its own. In a short time you will be able to make out the apparent shape of the cells. At first sight they appear to have hexagonal walls, reminding the observer of the cells of the hive-bee. But a little investigation will show that they really have twelve sides, their figure being that which is known in mathematics as a 'dodecahedron.' This form is caused by the mutual pressure of the elastic walls of the eggs, just as a number of candles will, if piled upon each other in a warm place, become hexagonal in the middle of the pile, and partly so in the upper rows. The original form of the eggs is spherical, as may be seen by examining those upon the outside of the mass.

Still we have another problem to solve. How did the eggs increase so rapidly and so enormously in size?

The key to this problem lies in two properties of membranes. One is called 'endosmosis'—*i.e.* the membrane permits liquids to pass from without inwards, but not back again. The other property, called 'exosmosis,' produces exactly the opposite effect.

Now, when the eggs are laid, each one is tightly enclosed in a very thin and elastic membrane, which possesses the property of endosmosis. Consequently, as soon as the eggs are immersed, water begins to make its way through the membranes, causing them to expand until the pores through which the water passed have become obliterated, and will allow no more water to enter.

Here, then, we have a vast number of spherical cells,

each containing a single egg, and allowing space for the newly hatched young to attain some little growth before they cope with the dangers of the world.

Now let us wait until some of the eggs are hatched, and examine the young which will proceed from them. At this period of their existence they are odd-looking objects, consisting apparently of nothing but a rather large head and a long, flat tail, so delicate in structure that if it were to be laid upon this page the shape of the letters could be seen through it.

In consequence of this structure, it is called by the popular name of 'tadpole.' This is a corruption of the original title 'tailed-poll'—*i.e.* tailed-head. The French name of *tetard* has exactly the same signification.

Perhaps some of my readers may remember the witty use which Tom Hood the elder made of the tadpole. He had been asked to devise appropriate names for the backs of sham books upon a library door. One of them was *Percy Vere* in forty volumes. Another was *Inigo Jones on Secret Entrances*. Another was entitled *Tadpoles; or, Tales out of my own Head*.

Even in this early stage of life the tadpole is worthy of a close examination. The transparency of the tail is so great, that when the creature is placed under the microscope the circulation of the blood is plainly visible.

Now look at the head, and you will see on each side a tuft of feathery membrane dividing into several branches. These branches are the gills, which have the same office as those of a fish, and do not differ from a fish gill in any important respect. Arteries and veins traverse their whole structure, and in them

the blood is purified, as in fishes, by being brought in contact with the oxygen which is suspended in the water.

Try to keep some of these tadpoles, and watch them pass through their transformations, which are every whit as wonderful as the development of a caterpillar into a moth or butterfly. The task is not at all a difficult one, and it is as easy to rear a tadpole as to breed a silkworm. The little creature is hardy enough, and only wants plenty of food. In the brook the tadpoles may always be found crowding under the bank, where they pick up plenty of food from decaying animal and vegetable substances, so that they are extremely valuable as scavengers, and assist in purifying the water.

Indeed, should you wish to prepare a skeleton of a mouse, a frog, a sparrow, or other small creature, and can have access to any brook or pond where tadpoles are to be found, the voracious little beings will save you nearly all the trouble. All that you need do is to remove the skin, sink the animal in the water, and leave it there. The tadpoles will soon find it out, and will swarm round it, nibbling it with their odd little jaws until they have eaten away the whole of the soft parts, leaving the bones still connected by the ligaments, which are too hard for the tadpole's jaws.

Should you be inclined towards the study of practical anatomy, you cannot do better than preserve a series of tadpoles, by placing them in small bottles full of spirits of wine, labelling each bottle with the exact age of its inmates.

I have before me a complete series of the frog from

the earliest to the latest stage of existence, and have found them most useful when special details are required. I obtained all the specimens from a little pond in a



TRANSFORMATIONS OF THE FROG.¹

paddock at Norwood, and kept them until they passed through their transformations.

¹ Fig. 1 shows a single egg, and Fig. 2 shows the same egg surrounded by the protecting membrane, respecting which a few words are needed. When the egg is first laid, it is surrounded closely by the membrane, so as to occupy as small a place as possible. But, owing to the property of endosmosis, which permits

Should you wish to study their internal anatomy, which is even more wonderful than the external form, do not attempt to dissect them at once, but leave them for some months, when the spirit will have hardened the tissues. If you should be able to wield the brush and pencil, make careful coloured drawings of the creatures, attaching to each drawing the name of the locality where the creature was taken, and its age when placed in the bottle. Take especial care of the gradual shrinking of the gills. Next, dissect carefully a similar series, and you will find that exactly in proportion as the gills diminish on the exterior, a pair of cellular lungs are developed in the interior. Thus, during a short period of its life, the creature is a true amphibian, breathing at the same time atmospheric air with its lungs, and inhaling oxygen from the water by means of its gills.

water to pass into the membrane, but not out again, the membrane becomes filled with water and stretched to its greatest extent, leaving plenty of room for the egg within it. At 3 is shown the young as it appears if taken from the egg shortly before hatching, and at 4 is seen the newly hatched tadpole. At this period of its existence the creature seems to be little more than a head with a tail growing from it, and without the very smallest trace of the future limbs. The reader will observe that on the side of the head there are some feathery tufts. These, in Nature, are pink, and are the gills. At this period, then, the creature is practically a fish. After a while, the gills are scarcely visible, as at 6 ; while at 7 they have completely disappeared, and a pair of legs have become developed. A corresponding change is taking place within the interior of the tadpole. In proportion as the external gills have been absorbed, internal lungs have been developed. At 7 a second pair of legs is seen, so that the creature looks like a frog with a tail. The tail is now rapidly absorbed, as seen at 8, and before very long it wholly vanishes, as at 9.

Now take an adult frog and examine it, beginning with the head. You will fail to find any external ears, but on looking at the sides of the head you will see at each side a round, smooth patch of skin very slightly sunk below the level of the rest of the skin. These are the drums or 'tympana' of the ears, which are in the batrachians as in the fishes a continuation of the skin of the head.

The nostrils are small and circular, and through them the animal breathes in a very remarkable manner. It first inflates its throat so as to fill it with air, and then seems to swallow the air. This act is performed by means of the 'hyoid' bones, which in these creatures play a very important part in respiration. As few people seem to know anything about these very important bones, I will give a very slight sketch of them.

If you carve an ox-tongue you will find at its base several little bones which scarcely seem to have any business in a tongue. These are some of the branches of the hyoid bones, which in the ox, as in man, have but little work to do, and are therefore small. But in one group of monkeys—namely, the Howlers—they are developed to a wonderful extent, and are formed into a sort of air-pouch, which enables the animals to produce the extraordinary sounds from which they derive their popular name.

In the woodpeckers, wrynecks, and other birds which feed upon the insects which lurk in narrow crannies, the hyoid bones are enormously lengthened, passing over the skull, and having their ends attached to the skull just at the base of the beak. By means of this mechanism

the bird is enabled to project its tongue to a considerable distance from the mouth, so as to secure the hidden insects.

In the fishes, as well as in the tadpoles, it is of great dimensions, and is divided into a number of branches for the purpose of supporting the gills. In the adult batrachia it is also used for the purpose of respiration, and by its alternate expansion and contraction forces the air through the lungs.

It is owing to this construction of the throat that the frog is able to produce the loud croaking sound which has earned for it the title of 'Dutch Nightingale.' In this country the croaking of the frog is so seldom heard that very few people would recognize it. But on the Continent the nightly noise of the frogs becomes an almost unendurable nuisance.

In the days of Louis XIV. and Louis XV., when the nobles condescended to leave the Court for a while, and pass a few weeks on their estates in the country, the peasants were obliged by law to flog the ponds with long sticks through the night, least the croaking should disturb the repose of their noble masters. Indeed, several country houses have in late years been quite deserted during the summer in consequence of the croaking of the frogs.

Perhaps I may introduce here an excerpt from the old legend of Bishop Benno and the frogs.

The Bishop was walking by the water side, and trying to recite his *Benedicite*, 'O all ye works of the Lord, bless ye the Lord, praise Him and magnify Him for ever.' Now for the legend, as versified by Mr. Baring Gould.

Bishop Benno vainly tried to sing the canticle as he stood :

Where about the margin grew
 Clusters of celestial blue,
 And the bog bean speckled pink,
 And the mares' tails with their spines,
 Stood and shook in shadowy lines,
 Wavering along the brink.

With their voices very shrill
 In a loud prolonging thrill,
 Half a chirrup, half a cry,
 Every little gullet shakes
 As its clamour from it breaks,
 Deafening the passers-by.

Whereupon the Bishop solemnly banned them in the name of the Church, and they were silenced. The Bishop proceeded with his singing, but when he came to the words, 'All ye that move in the waters, bless ye the Lord, praise Him and magnify Him for ever,' his heart smote him, and he reflected that the croaking of the frogs might be their song of praise, which he had no right to hinder. So,

Turning to the swamp he cried,
 'Sitters by the water-side,
 Do not ye your hymns forgo,
 I release you from the ban,
 Praise the God of Frog and Man,
 Cantate, FRATRES, Domino.'

The croaking of the frog only belongs to the male, just as is the case with the song of birds, and is sung for the same reason—*i.e.* as a mode of attracting its mate.

To our ears the nightly croaking of the frog would seem rather apt to repel than to attract a mate. So would the nocturnal wailings of the cat. But I have no doubt that to the ears of the frog and cat the croak and the squall are as dulcetly melodious as the song of the nightingale or skylark to the ears of birds and man.

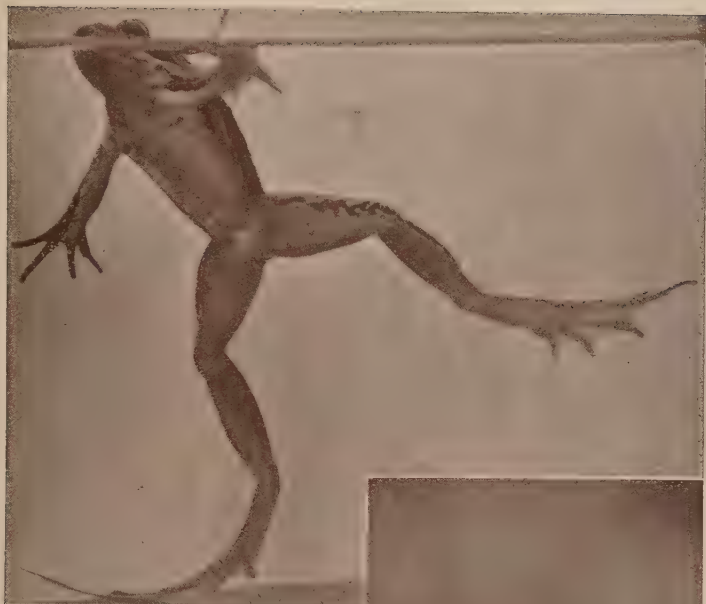
CHAPTER XVIII

FROGS

IN this country we make no practical use of the frog, though in many parts of the world it is an important though costly article of food. We are all familiar with the old gibe, that the French were a nation of frog-eaters, mostly contracted into 'Froggies.' For this absurd idea, Hogarth, Rowlandson, and George Cruikshank must be held chiefly responsible, they not having the least idea that frogs are expensive luxuries, and not a cheap food for those who can afford nothing of a more nutritious character.

Many years ago, when I was living in Paris with a French family, we occasionally used to have frogs as a special treat. In order to procure them it was necessary to be in the market by daybreak so as to be able to anticipate the stewards of the hotels, who had generally swept the market before six a.m. So we used to undertake the task in turns, being forced to get up at half-past four, so as to be in time. The frogs were always sold by women, who had two tubs, one so deep that the frogs could not jump out of it, and the other comparatively shallow, and having a leather strap nailed upon it, in which was stuck a short and very wide-bladed knife.

Each customer brought a basin tied up in a cloth, and



Frog Swimming.



Common Frog.

when a purchase was made, the woman plunged her left hand among the frogs which were in the deep barrel, brought out one of them, laid it over the edge of the shallow barrel, and with one chop of the knife severed it in two. The hind-legs were then handed to the customer, and the rest of the body became the perquisite of the vendor.

Cooking the legs of the frogs is a long and delicate operation, so that Hogarth's well-known drawing of a French officer roasting a row of frogs which he has spitted upon his sword is not only malicious but absurdly incorrect.

I cannot understand why in this country we should so persistently neglect the frog as an article of food. Our common frog, though not so large as the French species, is, when cooked in the same manner, every whit as good; and indeed, except for the difference in size, it would be impossible to distinguish between them. In America the frog is rapidly taking its place as an article of food, and I have often seen in the markets of Boston, New York, and other large cities, frogs' legs exposed for sale at so many cents per pair.

Frog-poaching seems to us in England to be a strange mode of earning a living, but in France frog-poachers are so plentiful that the owners of frog-preserves are obliged to take as many precautions as if they were English gamekeepers.

The implements used by the poachers are so simple and inexpensive that any one, however poor, can obtain them, while they afford no pretext to the police for arresting any one who might be found in possession of them. They consist simply of a long piece of string

and a little strip of red cloth. The cloth is tied in the middle to the end of the string, and then thrown into the pond where the frogs are kept. When it comes within range of a frog's sight it is taken for a worm and eagerly swallowed. The poacher then rapidly jerks his line out of the water, bringing with it the frog.

In order to baffle the poachers as much as possible, the ponds are enclosed within very high fences at some distance from the water. But an expert frog-fisher can even defy these precautions, and with a dexterous jerk can fling the frog over the fence with almost unerring certainty.

Next, notice the structure of the skin.

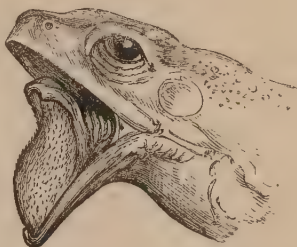
Frogs have the power of changing colour according to the hue of the surrounding objects. So a frog which would be nearly brown in one place will be bright yellow in another, the change being effected almost instantaneously, and its mechanism being similar to that which produces the change of hue in the chameleon.

Then, the skin is extremely porous, so that it permits water to pass through it in either direction. You may perhaps, on a hot summer day, have picked up the body of a frog. It will be reduced to a mere skeleton, with a skin stretched tightly over it, and the skin will be as hard as horn, so rapidly does the water exhale through the skin. I have before me the dried body of a green tree-frog which I picked up in the Crystal Palace. It had died in a natural crouching attitude, and is a perfect mummy of a frog.

Sometimes I have found a frog which was rapidly dying from deprivation of water, and have saved its life by simply wrapping it in a wet cloth, the skin

absorbing the water with astonishing rapidity, and soon restoring the animal to its usual sleek aspect.

Now open your frog's mouth and examine its tongue. You will find that it is attached to the mouth in a manner exactly opposite to that which is found among most of the higher animals. The base of the tongue, instead of being attached to the throat, as with us, is fastened to the front of the lower jaw, the tip of the tongue being directed down the throat. The tip of this peculiar tongue is coated with a viscid secretion, which affords the principal means by which the animal takes its prey. It feeds upon insects, grubs, and other small living creatures, provided that they be actually in motion.



HEAD OF FROG, SHOWING THE
TONGUE.

When a frog or toad sees an insect, it approaches cautiously until within striking distance, when it pauses for a moment as if taking aim. Then, with a motion so rapid that the eye can scarcely follow it, the tongue is suddenly flicked at the insect and as suddenly withdrawn, thus capturing the insect, and flinging it down its throat.

The toad, being a less active creature than the frog, is easier to watch. I once kept a pair of Natterjack toads for a considerable time. They were placed in a disused aquarium, with a piece of glass on the top, to prevent them from escaping, and to retain the insects which were placed in it as food for the toads. It was really wonderful

to see how certain was their aim, so that no insect, however active, could escape them for any long time.

Look at the frog as it sits in its usual attitude of rest, and note the outlines of its body and limbs. Artists, unless they have studied the anatomy of the creature, seldom represent it rightly. What causes the apparent hump on the back, and why do its hind-legs look as if they had a joint too many?

These questions can only be answered by inspecting the skeleton, which is well worth studying. There is not the least difficulty in preparing a skeleton for yourself, and you will learn far more from it than by merely studying illustrations.

If a frog be boiled, the flesh will come away from the bones with perfect ease, and if it be not boiled too long, the tendons will keep the bones together, so that the skeleton can be arranged into any form which you want it to assume. A few hours will be long enough to dry it sufficiently to be attached to a flat board for the convenience of handling. There are now before me several specimens which were prepared for me by a young friend, and which I have found very useful.

I have already mentioned that the frog has no ribs, so that there is quite a sudden transition from the spine to the hip-bones or pelvis. This part of the skeleton is of very great size, in order to support the enormously powerful muscles which are needed for the very long limbs, which serve the double office of legs and oars. The last joints of the spine are fused together, and form the odd-looking spike which runs between the halves of the pelvis. It is this structure which produces the hump-backed outline.

Now for the legs themselves. Generally speaking, there is no difficulty in identifying the bones of limbs, no matter whether we begin at the bases or extremities. But the hind-leg of the frog is exceedingly puzzling, even in the skeleton. Let us begin at the tips of the toes.

First there are the bones of the toes and instep (technically the 'phalanges' and 'metacarpals'). Then



SKELETON OF FROG.

come the ankle-bones, and then, as might be supposed, the two bones of the lower leg—*i.e.* the 'tibia' and 'fibula.' Next, we naturally expect the thigh-bone, but see at once that as that bone must be jointed to the pelvis, we must either have mistaken the bones, or that there is a long additional joint in the middle of the limb. We have, and very naturally, mistaken the bones. The two bones which we took for the tibia and fibula of the lower leg are in fact the heel-bone and 'knuckle-bone,'

which are greatly elongated, and bear a close resemblance to the bones for which they were mistaken. The tibia alone is developed, the fibula being reduced to a mere indication of a bone, and practically non-existent.

In this simple manner a supplementary joint is added to the hind-legs, and so endows them with the leverage that is required for leaping and swimming.

Now take your frog and put it into water, so as to see it swim. You will notice that it scarcely uses its forelimbs at all, but keeps them pressed closely against the body, so that the ancient metaphor, 'as a swimmer stretcheth forth his hands to swim,' would not be at all appropriate to a frog.

The chest-cavity of the frog is exceedingly large when compared with that of man, the large cellular lungs containing so much air that there is no need of spreading the arms in swimming. But the skin of the toes of the hind-feet is continued nearly as far as the tips, and the toes themselves are greatly lengthened, so as to offer a large surface to the water.

A friend of mine, though a powerful swimmer without any artificial aids, invented a set of adjuncts to the hands and feet which more than doubled his speed. When spread, they looked much like painters' palettes; but when the swimmer drew up his legs and arms for the return stroke, they collapsed and offered but little resistance to the water.

I mentioned just now the great size of the frog's lungs. Being composed of large cells, they contain much air. Now, the frog is one of the cold-blooded creatures, and does not require nearly so much air as a warm-blooded animal of the same size. It can there-

fore remain under water for a long time without needing to take breath. But it is no longer amphibious, as it was during a part of its larval or tadpole state of existence, and a too long immersion will drown it as surely as if it were a human being.

When I was quite a child I found a frog in the garden, and amused myself with it during the day. In the evening, wishing to benefit the creature, I put it into a pail half full of water for the night. I was prevented from seeing it in the morning, and on going to visit it in the afternoon was much surprised to find that it was dead. Most of us have read Æsop's fable of the hares and the frogs, but many of us may not be aware that if the frogs had jumped into a well instead of a river they would have been drowned just as certainly as the hares would have been.

I once met with an adventure which impressed me more forcibly than agreeably with the liability of the frog to be drowned when it is immersed in water for too long a time. I was visiting an officer of the Royal Artillery at Woolwich, and as the day was hot he suggested a swim in the great bath which is attached to the Military Academy. Accordingly I 'took a header' into the water, and swam about for some time. On nearing the bank, my nostrils were assailed by a most offensively putrescent odour, which I found to proceed from bodies of frogs. The edge of the bath was lined with the dead bodies in every stage of decomposition, and the odour was almost overpowering. The cause of their death was evident. They had leaped into the water as usual, and had not been able to get out again, the sides of the bath being stone, which they could not climb.

If you would like to see for yourself the circulation of the blood in the frog, and have access to a microscope, you can do so without any difficulty. Most microscopes are furnished with a 'frog-plate'; but if there should not be one, you can make it in five minutes or less. Take a piece of strong pasteboard or thin wood, about four inches long and an inch and a half wide, and near one end cut a hole about an inch in diameter. The shape of the hole is a matter of indifference.

Now make a little calico bag, just large enough to receive a moderately sized frog. Fasten a string to each corner, and let the mouth be closable with draw-strings. Put the frog into the bag head first, taking care to leave one hind-leg projecting, and then draw the strings just tightly enough to prevent the frog from pulling its leg into the bag, but not so tightly as to hinder circulation. Now tie the bag to the plate in such a way that the hind-foot can be fixed over the hole. It is as well to tie a string over the leg so as to keep it down.

Now tie a thread to the tip of each toe and draw them apart, so as to spread the web as much as possible. You can fasten the threads where you like by cutting notches on the edges of the plate. Dip the plate and bag into water, and take care to keep the bag and leg moist. Place the stretched web under the microscope, using a 'quarter' or 'four-tenths' object-glass, and you will be rewarded with a most wonderful sight, the oval globules of blood coursing in all directions, apparently chasing each other, as if they were separately endowed with life.

At first you will not see the vessels through which the

globules are directing their course, but after a little practice you will be able to detect their very delicate outlines. Be sure to have a good light reflected from the mirror. Should the globules be sluggish, or occasionally stop altogether, relax the mouth-strings of the bag, and you will soon see them careering on their course.

CHAPTER XIX

TOADS AND NEWTS

TOADS.—As to the Toad, its general life-history is very similar to that of the frog. The eggs, however, instead of being laid in great masses, are deposited in long double strings, set alternately in the enclosing membrane.

You need not be in the least afraid of the toad, which is quite as harmless, though not so pleasing in form, as the frog. Yet uneducated people are horribly afraid of it, and tell all kinds of absurd stories about its noxious qualities. In the days when belief in witchcraft was general, the toad played a very important part among the ingredients employed in sorcery. That even Shakespeare believed it to be a venomous reptile is evident from many passages too familiar to need quotation, and we need not therefore feel surprised that people of intellects far inferior to his should hold the same belief.

While writing these lines I happened to be in Ayr, and came upon a book of records of Scottish superstitions. Among them was an account of the trial for witchcraft of Agnes Sampson, at Lammas, 1590. I transcribe a few sentences of the report, but, in order to make the very Doric dialect intelligible, have modernized both the language and spelling.



Common Toad. *Bufo variabilis*. Natterjack Toad.

‘Then some of them (*i.e.* the witches) were enjoined to hang, and roast, and “drop” a toad, and to lay the droppings of the toad, mixed with strong wash and an adder’s skin, in his majesty’s way, that it might fall upon his highness’s head or his body, for his highness’s destruction.’

The record then proceeds to state that a toad was hanged by the heels for three days and nights, then roasted, and then ‘dropped’ in three oyster-shells set on nine stones.

The toad is a wonderfully easy creature to tame. My children had for several years their pet toads. The reptiles used to sit upon their outstretched hands, and flick the insects from the flowers as they were held up by the children.

I have already mentioned that for some months I kept several Natterjack toads in a disused aquarium, and was much interested by the wonderful certainty with which they captured any insect which was placed in the aquarium. It might be a caterpillar, or a beetle, or a hornet, or a wasp, and might crawl, or run, or fly, as much as it liked, but sooner or later the toads were sure to have it. They cared nothing for the stings of the bees and wasps, although after they had swallowed a large insect it could be seen moving for some time, its legs pressing against the ribless flanks of the toad, and its struggles being perfectly visible.

When a toad seizes a large and powerful insect, such as a humble-bee or a ground-beetle, it proceeds in a rather remarkable manner. Fixing its eyes intently on the doomed insect, it follows its movements for some time, always managing to approach nearer and nearer

until it can strike the fatal blow. The insect being too large to be swallowed at once, the legs and wings, if it be a winged insect, are seen projecting at each side of the mouth. Presently the toad gives one or two great gulps, its eyes almost disappearing in the effort to swallow, the front paws push the offending limbs into the mouth, and presently the eyes resume their position, and the insect has vanished.

I was much surprised to see the height to which they could reach when the insect was above them. They would stand on their hind-feet, and seemed to be able to stretch themselves as if they could elongate both body and limbs.

The Natterjack is, by the way, much handsomer than the common species, being smoother, of an olive-brown colour, and having a narrow yellow stripe along the spine.

Awkward as they may seem when compared with the frog, the toads are wonderfully good climbers, so that they frequently make their homes in a hole in a tree-trunk at some height from the ground. They have sometimes been known to climb a perpendicular wall, and to ensconce themselves in crevices. Like cats, the toads are fond of squeezing themselves into places which seem scarcely capable of containing them, and connected with this habit is a singular episode in the life-history of the animal.

Our batrachians are hibernators, passing the cold months of the year in a state of torpidity. Now, the bark of trees always has a tendency to grow over a hole, and at last to obliterate it entirely. So, when a toad has laid itself up for the winter in a hole only just large enough to contain it, the continually growing bark may

reduce the size of the hole so greatly that the toad cannot force its way out again, and so is imprisoned for life.

Many stories are told of toads which have been found alive in solid timber, but I believe that no proof has as yet been given that the timber was really solid, and that no crevice existed through which air and minute insects could have reached the imprisoned animal. Reptiles require but little air, and can subsist upon a very small amount of food at long intervals, so that a tiny crevice which would escape the notice of the sawyer, or be actually obliterated by the saw, would be sufficient to supply the toad's needs.

Similar stories are told of toads imbedded in solid stone, but none of them has stood the ordeal of scientific investigation.

Some years ago there were sensational accounts of a toad imbedded in coal. The late Frank Buckland and myself were asked to examine the toad and the block of coal. We made our investigations independently, and both came to the conclusion that the toad had fallen or been carried accidentally down the mine, and had found a convenient cavity in which to conceal itself.

It will be scarcely necessary to mention that the batrachians hibernate on dry land, often choosing spots at a considerable distance from water. There is a popular but erroneous idea that the phenomenon of hibernation is produced by severe cold. This, however, is not the case. A certain amount of cold there must be, but a very low temperature first awakes the animal, and then kills it. I once came unexpectedly on a striking instance of this fact.

A few years ago, a large amount of snow fell at Norwood, and a severe gale had caused it to drift into a hollow on a hill. Suddenly a rapid thaw set in, and the hollow became filled with water. One side of the hollow gave way, and the water poured down the hill, carrying away a few yards of a footpath which skirted the side of the hill. On reaching the spot, I was rather surprised to see a dead frog, and then several others lying down the slope. On examining the damaged path more carefully, I found a hollow under the path, and in it several more dead frogs. They had evidently hibernated there, and had been washed out of their hiding-place and killed by the cold, though the temperature was above freezing-point.

Take notice of the eye of a toad, and you will be surprised at its beauty, should you not have previously examined it. Stuffed toads, like stuffed snakes, always have an unnatural look about them, owing to the taxidermist employing birds' eyes with circular pupils instead of the very peculiar eyes which belong to these reptiles. Whenever I 'set up' a toad, I insert plain black eyes, and then paint them of the proper colours and with correctly shaped pupils.

As the toad is nocturnal in its habits, being able to see its prey in the dusk, it does good service to the gardener and agriculturist by ranging among the vegetation and devouring the many destructive insects that hide themselves during the day, and whose very existence is seldom suspected. Of late years gardeners have learned to appreciate the value of the toad, and purchase the reptiles in large numbers, keeping some in their greenhouses, and turning the others into the garden.

One branch of entomology is greatly indebted to the toad. There are many nocturnal beetles which can only be taken at night, and even if a coleopterist should give up the night to their pursuit, will escape on account of his lantern, the light sending them back into their hiding-places. Now, digestion is rather slow in the toad, especially as it always swallows its prey alive. So, the entomologist goes out just before daybreak, captures every toad that he can find, kills them, and among the contents of their stomachs he is sure to find some beetles which he could scarcely have taken with his own hands.

Bee-keepers naturally hate the toad, because it has a habit of sitting under the hives and snapping up any tired and overladen bees that may fall from the footboard. Moth-hunters hate it for a similar reason, the toads finding out the 'treacles,' and swallowing the intoxicated insects as they fall from the treacherous dainty.

Newts.—That ignorant people should be afraid of toads, we can understand for two reasons, the one being long-standing tradition, and the other the ungainly aspect of the creature. But why any one should be afraid of the graceful and beautifully coloured smooth-skinned newt is not so easy to understand. Yet, among the uneducated classes, the newt is regarded with abject terror, and the average rustic would as soon handle a viper as a newt-eft, or 'evat,' as the creature is called in various places.

It seems strange that those who live in the country, and have the best opportunities of studying the habits of animals, are mostly as ignorant of their distinctive aspects, their food, and indeed of their life-history generally, as if

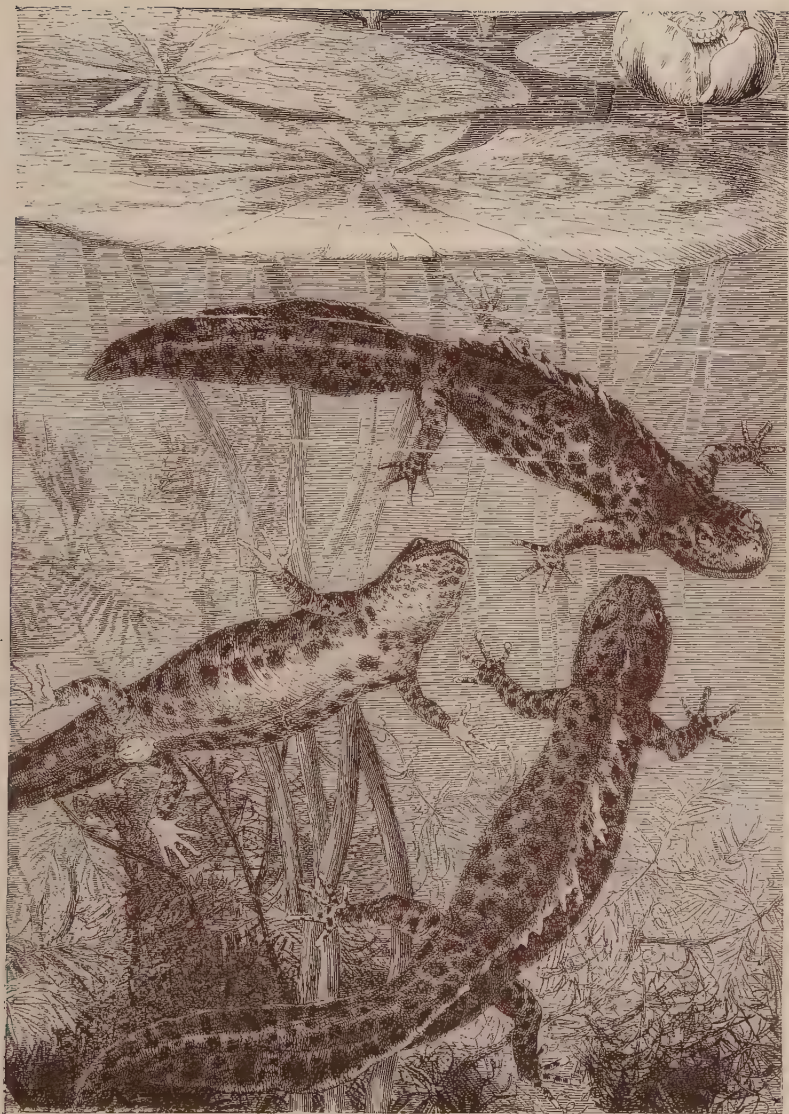
they had passed all their days in the heart of some great city. One day my son, when a little boy, had taken a newt and showed it to the gardener. The man was horribly frightened, and besought him to throw it down before it bit him, in which case 'he would go on swellin' and swellin' until he busted.' A similar belief prevails in France.

A still more absurd idea of the mischief-working powers of the newt is, that it can bite a piece out of the flesh, and spit fire into the wound. I have several times heard this assertion made and supported by circumstantial evidence.

There are several species of British newts, but they are identical in general structure and habits. I shall therefore take the common Crested Newt (*Triton cristatus*) as our type.

The mode in which the newt deposits its eggs differs essentially from that which is employed by the frog and toad. Those animals merely drop their eggs into the water, and let them shift for themselves; but the newt deposits each egg separately, twisting it up in the leaves of various aquatic plants, using her hind-legs by way of hands. I have seen these eggs folded into the long slender leaves of vallisneria in an aquarium, and very much admired the deft manner in which, with such imperfect implements, the mother newt had managed to twist the leaves around the eggs. The eggs are, when newly laid, of a pearly hue.

The tadpole of the newt is at first almost exactly like that of the frog, but when the legs begin to be developed there is no difficulty in distinguishing between the two creatures, the hind-legs of the frog being the



Great Water-newts.

first to show themselves, while in the newt the fore-legs are the first to appear.

Unlike the frog and toad, the newt retains its tail throughout its life, and uses it as its chief means of locomotion in the water, just as the fishes do. The lithe grace of the newt as it makes its undulating way through the water is a positive feast to the eye, and can be seen to best advantage in an aquarium. Indeed, it is impossible to observe the creature properly in any other way, as a horizontal view is needed in order to see its movements. Some time ago, while staying in the house of an architectural friend, I heard him put the same point in professional language. I had made a sketch of a stickleback, to which one of the party objected as being too deep in the body. My host, however, settled the question by saying that my drawing was an 'elevation,' and not a plan.

All the batrachians cast off their epidermis at intervals, but have different modes of performing that operation. The frogs and toads first swell their bodies until the skin splits along the back, and then push it off with the aid of the fore-paws, which they use as hands. Then, holding the cast skin between their paws, they pat and roll it into a ball and swallow it. Indeed, all the batrachians make great use of their paws in feeding. When, for example, a toad has seized a long-legged insect, and is incommoded by the legs projecting at the corners of its mouth, it places one of its fore-paws at either side of its mouth, and literally tucks in the offending members.

The newt acts in similar fashion. I never saw it feed on land, but when in the water it eats a worm, it always

seizes the creature by the middle, and then, with a series of sharp, snapping bites, disposes of it, tucking in the dangling ends as they writhe about during the process. The paws of the newt are also used in getting rid of the shed skin, but, although I have kept many newts, I never saw one eat its skin. The abandoned epidermis is left floating in the water, where it looks like the ghost of the former owner.

Generally the skin is shed in several pieces, and I never succeeded in obtaining a whole one. But a lady kindly sent me two specimens mounted on cardboard. They are quite perfect, and were obtained by slipping a card under the skin as soon as it was shed. While still under water, the skin was carefully spread upon the card, just as seaweeds are mounted, and then lifted from the water and allowed to dry. No cement of any kind was required to fasten the skin to the card, the delicate membrane adhering to the card without the help of any other material.

In common with the crustacea and many other creatures, the newt has the power of reproducing a lost limb. Spallanzani found that the same newt reproduced several successive sets of limbs.

As is the case with the stickleback, the male newt assumes very gorgeous apparel during the breeding-season. He even surpasses the stickleback in one respect, and, like many birds, adds a beautifully coloured crest to his ordinary form, losing it as soon as the season is over. The bird's crest is made of feathers, which are shed at the moulting-time, but that of the newt is membranous, and, instead of being shed, is absorbed like the tail of the tadpole. It extends from

the head to the beginning of the tail, is edged with scarlet, and is deeply notched, like the comb of a cock. It is not, however, thick and stiff like a cock's comb, but is so thin and delicate that when the creature is removed from the water the crest lies along the back, and can scarcely be recognized. The under surface of the body is bright orange, spotted with black.

The newt has the power of uttering a faint but easily heard cry. The frog, too, when alarmed utters a loud cry, quite unlike the croak with which we are so familiar. When it is pursued by a snake, and finds that it has no chance of escape, it almost invariably ceases from its efforts, and, with a cry of despair like that which a hare utters when she falls into the jaws of the hounds, yields itself to the destroyer.

CHAPTER XX

THE REPTILES OF THE BANKS

HAVING cursorily viewed the life-history of the semi-reptiles called Batrachians, we will try to find some of their nobler relatives upon the bank.

There are but very few reptiles in this country, so that even if we had the whole of the British Islands at our command, instead of being confined to the brooks and their immediate neighbourhood, the number of species would be greatly restricted. However, we shall probably be able to find a type of every reptile which inhabits England.

Lizards.—On a hot, dry day, especially if no rain has fallen for some time, if we come to a sloping brook-bank with a southern aspect, so as to be attractive to insects, we shall probably meet with the common Scaly Lizard (*Zootoca vivipara*).

Some art is required even in detecting the reptile. It prefers banks where dried leaves have been allowed to collect, and where long mosses and similar growths afford it shelter. Even on the most favourable of days, you may come on just such a bank, and watch it as long as you like, and you will not see a single lizard. Yet there may be plenty of lizards within a few feet. The fact is that they are among the wariest of creatures,

and are as sharp of eye and ear as they are wary. Though you cannot see them, they can see you, and are wondering when that great, clumsy creature is going away, so that they may catch their flies in peace.

Here again is an instance of the oft-repeated rule in observing Nature—*i.e.* the maintenance of absolute stillness. So, when in your rambles by the brook you come on such a bank as I have mentioned, walk to it as gently as you can, and sit down where you can command a view of the bank without turning your head, as the slightest movement will keep the lizard out of sight. Move your eyes as much as you like, but not your head.

Again, when engaged in observation, always keep your back to the sun. In the first place, your eyes will not be dazzled just when you want them most; and in the next place, the sun's rays attract a wonderful variety of living creatures, and aid in detecting them when they show themselves. More important than all, few people can look towards the sun, or, indeed, towards any brilliant light without sneezing, and a sneeze is fatal to observation.

Suddenly, you know not how, there is a lizard on the bank. It is quite motionless, and might almost be a stuffed skin. The next moment it darts upon some passing insect, and catches it with a snap of the jaws as quick as a serpent's stroke. These lizards are seldom alone, so that when you see one you can make up your mind to see several. Make the slightest movement, and every lizard will have vanished as mysteriously as it appeared, and some time will elapse before the suspicious little beings will again show themselves.

Note the peculiar movements of the creature, which are

characteristic of reptilian nature. The lizard never seems to have any medium in its movements, but is either absolutely quiescent or darts about with such speed that the eye can scarcely follow it. I do not recommend its capture for domestication, as it seldom lives in a house, and, moreover, it never shows itself to advantage except when among its natural surroundings.

I need scarcely say that this lizard is absolutely harmless. Indeed, the only venomous reptile in this country is the viper, a creature of which we shall see something presently. Yet in many parts of the country it is dreaded as deeply and as unreasonably as the newt and the toad. In the *Daily News* of October 30, 1880, there appeared an account of a drive through several parts of Ireland. The traveller asked the driver whether that district was safe for English travellers, and received a most unexpected answer.

‘Ye might lie down and sleep anywhere, and niver a soul would hurt ye, barrin’ the lizards in the summer-time, and they are dreadful, are lizards. They don’t bite ye like snakes, or spit at ye like toads, but if ye sleep wid ye’r mouth open, they crawl, just crawl down ye’r throat into ye’r stummick, and kill ye. For they’ve schales on their bodies, and can’t get back, and they just scratch and bite and claw at ye’r innards till ye die.’

Almost all lizards are good swimmers, but I believe that the scaly lizard does not enter the water voluntarily. At all events, I have frequently put them into water, and always found them behave in the same manner. At first they seem entirely bewildered at the sudden change, and lie floating on the surface with outstretched legs. Suddenly they seem to understand the situation, and with a rapid,



Sand Lizards.

undulating movement of the long tail row themselves to land.

The total length of this little reptile is six inches, and its colour is brown above, diversified with small spots and splashes of black. The under surface is olive-grey in the female, and orange spotted with black in the male, so that there is no difficulty in distinguishing between the sexes.

Should you wish to catch one of these lizards for closer investigation, it will be useless for you to snatch at it with your hand. The lizard is quicker than you are, and can easily escape from the swiftest grasp. The net is almost equally useless, especially as the banks on which the lizard is found are mostly of such a nature that the net cannot be used. But you can catch the creature easily enough by trading upon its reptilian alternations between immobility and lightning-like swiftness. When one of the lizards comes within half-arm's length, and is remaining quiescent, move your hand towards it very gently, so as not to disturb it by a sudden movement, taking care not to throw a shadow on the wary creature. When your hand is just over it, pounce suddenly upon it, and if you are nimble of touch you will secure the lizard before it has time to take alarm.

By trusting to the same reptilian sluggishness, the late Charles Waterton was accustomed to handle the most venomous snakes as if they were perfectly harmless. There are persons still living who saw him at Leeds carry with his bare hands twenty-eight living rattlesnakes from one room to another, shift them into a glass case, and afterwards carry them back and replace them in the box whence they were taken. He once explained

the whole process to me, using my wrist to represent a snake.

The **Blind-worm**, or **Slow-worm** (*Anguis fragilis*), is a pretty little creature. This very common and very remarkable lizard, which is mostly mistaken for a snake,



BLIND-WORM OR SLOW-WORM.

because it has no legs, will be found in much the same localities as are inhabited by the preceding reptile.

Here I may mention that in the earlier days of English literature, the word 'worm' was often used as synonymous with snake or dragon, and was not employed in the restricted sense of the present day.

The name of slow-worm is perfectly appropriate, as

the creature, from the nature of its food, does not need the quick, darting movements which are necessary for the lizards which live on flies and other active and wary prey. If you see a blind-worm, you may make nearly certain of catching it, as long as it cannot slip out of sight under the shelter of dense herbage or bushes.

But why it should have been almost universally called by the name of blind-worm I cannot understand, as its eyes are, though small, very bright, and so conspicuous that the least observant can scarcely fail to notice them. The reptile could not take its prey without the aid of eyes, and it would be as absurd to attach the title of 'blind' to the frog or toad as to the slow-worm.

Neither can I imagine why the creature should almost universally be dreaded as poisonous. The slightest examination of its mouth will show that it has no venom-fangs, and that its teeth are so small that they can do no harm to man. I have handled any number of blind-worms, and only once knew them to bite. Even in that case I believe that the reptile was not urged by anger, but by hunger.

When I was living at Norwood, I received a message from some ladies who occupied a house not far from mine, that some terrible animal had made its way into the garden, and no one dared to touch it. So I went to the garden, and was shown one of the wooden sockets in which clothes-posts are set when needed. At the bottom of the socket was a blind-worm, coiled up as if asleep. To the horror of the spectators, I took it up, and, to their still greater horror, it felt about with its jaws for a while, occasionally putting out and withdrawing its black, flat, cleft tongue, and then seized the fold of skin at the

junction of my first and middle fingers. The spectators fully expected to see me drop down dead, and could scarcely believe their eyes when I took it to them, and showed them that no harm was done. The strength of the jaws is astonishing for so small a creature, and though the little teeth could not penetrate the skin, they pinched rather sharply.

When once it takes hold, the blind-worm retains its grasp with the tenacity of a bull-dog, and I had much difficulty in inducing this specimen to release my finger. I held it under water for some time, but without the least effect, and at last I was obliged to force its jaws open. The skin was lightly bruised by the pressure of the jaws, and the marks of the teeth were perceptible for some little time. But, although the reptile had selected a spot where its jaws could be used with the best effect, and was allowed to retain its hold for fully half an hour, the skin was not broken in a single place. Why I believe this blind-worm to have been urged by hunger when it seized my hand will presently be shown.

When I was staying in the New Forest, where all reptiles abound, I found that the blind-worm was far more dreaded than the viper, and when I caught a blind-worm with my bare hand, and allowed it to twine itself about my fingers, and held it against my face, the bystanders, with one accord, concluded that I had some potent charm which disarmed the terrible reptile of its venom; but no one believed that it had no venom of which to be disarmed.

The late Dr. Sneyd-Kynnersley was on very friendly terms with an old Welsh sexton, and took down verbatim

some of his remarkable experiences. Here is the sexton's account of the blind-worm :

'The "slower-worm" stings horrible. Not long ago in the churchyard I found a slower-worm, and, being in a playful humour, I put it on a flat tombstone, and wouldn't let it go where it wanted to. So its temper was roused, and there came a little dog to the place, and the slower-worm it darted at the little animal, and bit its foot fearfully, and it yelped and licked its poor little toe.'

Now, as far as my own experience goes, the blind-worm never darts at anything, its movements being deliberate in the extreme, and I cannot but think that the worthy sexton had mistaken a viper for a blind-worm, the aroused temper and the sudden dart at a supposed enemy being characteristic traits of the viper, but quite opposed to the deliberate movements and unresisting nature of the blind-worm.

The late Frank Buckland had once an absurd adventure, in which the blind-worm played an unconscious but prominent part. Some years ago the New Zealand chief, Tomarti Hapiromani Wharinaki, with several other chiefs of less rank, came to England as a deputation about the land question. After his wonted custom, Frank Buckland made their acquaintance, and asked them to his house.

After dinner he took them to the monkey-room, so that they might smoke, and showed them some of the many curiosities which were in the room. Among them he produced a box in which were a number of blind-worms. The New Zealanders gave a simultaneous yell of terror, sprang out of the open window into the garden,

scrambled over the garden wall into the next garden, then into the next, yelling loudly all the time. The yell of a New Zealander must be heard to be realized. A few doors farther down the street, an old lady was sitting at her work at an open window. To her great terror, two of the tattooed fugitives jumped through the window, in hopes of finding a safe refuge from the dread reptiles. They were pursued, and with some difficulty were induced to return, when it appeared that they took the blind-worms for N'gara—*i.e.* the principle of evil.

I have an idea that the reason why the blind-worm is thought to be venomous is, that the reptile frequently puts out its tongue. Now, even fairly educated people generally think that the tongue of a snake is its 'sting,' and they naturally hold the same opinion regarding the blind-worm.

The food of the blind-worms consists almost entirely of the small white garden slug. Shakespeare, who, as we have seen, was not proof against popular prejudices, shared the general ideas concerning the blind-worm. For example, in *Timon of Athens*, he speaks of—

The gilded newt and eyeless venom'd worm ;

while every one must remember the exquisite lullaby in the *Midsummer Night's Dream*—

Ye spotted snakes with double tongue,
Thorny hedgehogs, be not seen,
Newts and blind-worm do no wrong,
Come not near our Fairy Queen.

It is said to feed on various insects, and may do so.

But I have kept many blind-worms, and never knew them to eat anything but the slug. When it seizes its prey it does not dart at it, but, in the most deliberate fashion, grasps it by the middle of the body, pinching it so tightly that it squeezes the soft mollusc out of all shape. It continues alternately to bite and relax its hold until it has worked the slug into a favourable position, and then, with a series of bites and gulps, forces the slug down its throat, head foremost.

When the captured blind-worm seized my finger, it incessantly tightened and relaxed its hold, so that I have no doubt that the soft and yielding skin deluded the reptile into the idea that it had caught its usual prey.

Its habit of slug-eating makes it a valuable inhabitant of a garden, so that the two feared and despised creatures, the toad and the blind-worm, are directly useful to agriculturists; the one to eat beetles and grubs, and the other to destroy slugs, both of them working at night.

The young of the blind-worm are much more snake-like than when adult. One of my tame blind-worms produced nine little ones during a night in September. I was much surprised, not only at their snake-like aspect, but at their singular resemblance to the viper, even a black mark like an inverted V being seen on the head. Besides this, there is a Y-like mark on the head, the stem of the Y being prolonged into a narrow black line, which runs along the whole of the back. The upper surface is yellow, and the lower surface is shining black. Moreover, the neck is very narrow just behind the head, so as to increase the resemblance to a snake.

When adult, the neck is nearly as wide as the head, and the colour is olive-brown above, with a narrow dark

line down the back, and another on each side. The under surface is black, and there is a peculiar silvery lustre about the creature which renders it easily recognizable. The entire length of a fine specimen is rather more than thirteen inches, seven and a half inches belonging to the tail.

Looking at the illustration, you might be disposed to consider the reptile as being all tail. But if you can manage to capture one of these creatures and examine it carefully, you will see that the beginning of the tail is marked by a slight but sudden diminution of the diameter, the tail tapering to a point, and being partly prehensile.

Connected with the tail is a remarkable phase in the life-history of the creature. The attachment of the first vertebra of the tail to the last vertebra of the body is exceedingly slight, while the muscles are short of fibre, but very strong. If the blind-worm should be roughly handled, or even suddenly alarmed, it contracts the muscle of the tail so violently that the whole member snaps off, leaving the reptile not quite half as long as it was a few seconds before. Hence the specific name of *fragilis*, which explains itself. As we all know, lobsters and crabs are similarly able to shake off a limb when needed. Although the tail is severed from the body, the contractile impetus given to the muscles continues to act, and the severed tail twists and jumps about as if it were a separate animal endowed with its own life.

The object of this singular property is evident to those who have seen the blind-worm shed its tail. The attention of the disturber is naturally arrested by the

movements of the severed tail, and in the meanwhile the owner slips quietly out of sight and conceals itself. I have seen a tail jump several inches from the ground, and continue the movements for some minutes.

Like the crustacea, the blind-worm has the power of reproducing the member, but the new tail is always shorter and more stumpy than its predecessor, and does not possess quite so much prehensile power.

Other lizards beside the blind-worm are capable of reproducing a lost tail.

The late Captain Marryat found, when he was stationed at Madeira, that if he caught a lizard by the tail, the animal sprang away, leaving its tail in his grasp. 'Now, the tail of the lizard is longer than the body, but I soon found out that lizards did not die from this extensive loss, but, on the contrary, that their tails grew again. Even the first week afterwards a little end began to show itself, and in about two months the animal had reproduced the whole. What I am about to say will probably be considered by some as incredible; they are, however, at full liberty to disbelieve it.

'One day I was looking out of the window with the late Tom Sheridan, who lived in the same house, and we observed on the roof of the outhouse a lizard with two tails, but neither of them full-grown, and we argued that at the time the animal lost his tail he must have suffered some division of the stump. I immediately caught a lizard, pulled off his tail, notched the last vertebræ of the stump, and turned him loose again. Our conjectures were right, the animal in two or three weeks having two tails growing out like the one I had seen. I repeated this experiment several times, and it always seemed

to succeed, and all the two-tailed lizards were called mine.'

Like other lizards and the whole of the snakes, the blind-worm sheds its epidermis at regular intervals, sometimes peeling it off in one piece, but mostly stripping it away in fragments.

CHAPTER XXI

SNAKES OF THE BANKS

THE banks of a brook are always favourite haunts of the common Grass-snake.

The Grass-Snake (*Tropidonótus natrix*) is sometimes called the **Ringed-Snake**.—The specific name, *natrix*, signifies a swimmer, and is given to this species on account of its fondness for water, in which it is almost as much at home as if it were an eel. The generic name, *Tropidonótus*, is composed of two Greek words, signifying keel-backed, and is given to the members of that genus because the scales of the back have a ridge, or keel, running along their centre.

Before examining the life-history of this particular species, we will glance at the characteristics of the snakes as a class.

As a rule, the very sight of a snake of any kind excites in the minds of most people a feeling of such repugnance, often largely mixed with fear, that they never realize how wonderful a being a snake is, or ask themselves how a vertebrated animal, which is practically nothing but a tail with a head at one end of it, can perform so many and so distinct offices. It has no limbs, and yet, with the exception of flying, can do anything that is done by creatures which are provided with the full complement of four limbs.

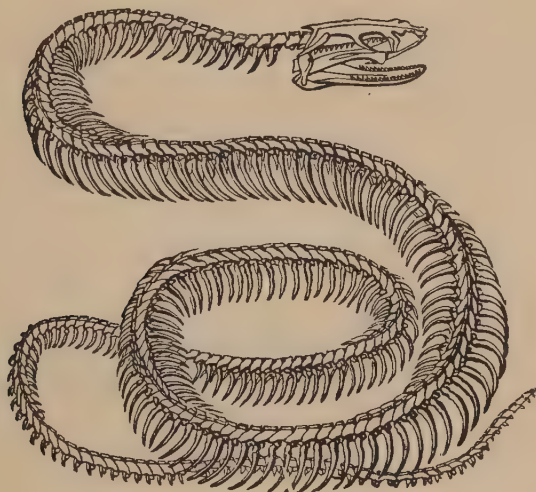
Snakes can run with a speed that is almost incredible to those who have not seen them. Some can climb trees with marvellous agility. Sir Emerson Tennant states that the Emerald Whip-snake of Ceylon will, if disturbed, 'dart upward through the branches and over the leaves, which scarcely seem to bend beneath its weight. A moment more, and you have lost sight of it.'

Some can capture prey by flinging the coils of their bodies round the doomed creature, just as a Mexican hunter uses his lasso. One species, the Racer-snake of America, although without poison-fangs, has been known to kill the terrible rattle-snake in a most extraordinary manner. Apparently, the racer would have no chance against one of the deadliest serpents in the world; but the marvellous agility of the racer was more than a match for the fangs of its antagonist. It flung two coils of its whip-like body over the rattle-snake, straightened itself, and in a moment cut the rattlesnake in two pieces, the whole process occupying barely half a second.

Then, as already mentioned, snakes are good swimmers, some of them passing their whole lives in the sea. Others again can leap to considerable distances, although they possess no legs. There is one thing, however, which they cannot do. No snake can move with the up-and-down undulations which artists are so fond of depicting. The snake can curve its body sideways or downwards, but cannot bend its body upwards, owing to a bold ridge on the upper part of each vertebra.

By what wondrous mechanism do the snakes perform these feats? Simply by the application of the ball- and socket-joint. In our own skeletons we have this joint

developed to a considerable extent in the shoulders and hips, but the snake is composed almost entirely of ball-and socket-joints and the muscles by which they are worked. The body of each vertebra has a socket in front and a ball behind, so that the vertebræ fit into each other in a most beautiful manner. I have before



SKELETON OF SNAKE.

me a number of vertebræ belonging to the boa-constrictor, and every one who sees them for the first time is struck with their wonderful beauty.

The same principle is carried still farther. From either side of each vertebra projects a bony 'process,' to which a rib is attached. But at the end of each process there is a rounded ball, which fits into a socket at the expanded base of the rib. Thus the ribs are

capable of free movement, each pair of ribs being independent of those before and behind it. The accompanying illustration will give a general idea of the snake's skeleton, though, on account of its small size, the details of each vertebra and its accompanying pair of ribs cannot be shown.

Now, look at the upper and lower surfaces of any snake, and you will at once see that there is a total difference in their structure. The upper surface is covered with scales arranged so as to overlap each other like the tiles of a roof, while the greater part of the lower surface is defended by broad bands of horny material, each slightly overlapping its successor. Each of these bands is attached to a pair of ribs. Here, then, is the mechanism, and we will now see how it is used.

Despite the speed upon the ground, the activity among the branches, and the power of swimming in water, a snake is helpless if placed on a perfectly smooth, flat surface, such as a large plate of glass, and can only wriggle about, without advancing a single foot.

I have already mentioned that each of the horny bands is moved by its own pair of ribs. So, when the snake wishes to advance, it pushes forward successively the ribs from the shoulder to the tail, and, in point of fact, walks on the tips of its ribs. But it is evident that the ribs cannot be left unguarded, while it is equally necessary that they should be able to act as fulcrum by which the body is propelled.

This double object is attained by the horny plates or bands to which the ribs are affixed. When one pair

of ribs is pushed forward, the horny band is thrust forward with them, its sharp edge hitching against the least irregularity of surface. This process being repeated with each pair of ribs in succession, the whole body is brought forward just like that of the earth-worm.

The snake cannot 'back' itself, but that is of no consequence, as the extreme flexibility of the vertebra enables it to double its body on itself, and so to retrace its course without actually backing. Now the reader will understand why a snake can make no progress on an absolutely smooth surface, there being no irregularities on which the edges of the bands can hold.

When a snake ascends a tree, it does not coil itself like a screw round the trunk, as is generally represented by artists and taxidermists. It presses its body closely against the tree, keeping it nearly straight, and glides upwards by hitching the edges of the bands against the irregularities of the bark.

When in water, the snake moves its body in lateral curves, so that it swims just as an eel does, the whole of its body performing the office of a fish's tail.

Many years ago I had a number of pupils near Shrivenham in Wiltshire. Almost every boy had his own pet snake, which he carried in his jacket pocket. Now and then the boys would take their pets into the country, and allow them a run on the downs, where no underwood or dense herbage grew, so that there was no chance of escape. Sometimes they visited a disused stone quarry, half full of clear water, put them into the water on one side, and recovered them at the other after they had crossed.

Sometimes a snake took a fancy to a dive, and declined to come up again. Then, as no stick could be found of sufficient length to reach the snake, stones had to be thrown into the water, in hopes of startling the reptile. But to touch the snake was no easy task, for stones never sink perpendicularly in water, always swerving from side to side. More than once a snake was so obstinate that it could not be induced to stir, and, to the grief of its owner, had to be left in the quarry.

The question now arises, How could the snake remain for so long a time under water without needing to breathe? The query is a very natural one, and for its solution we must look at the construction of the lungs. In the first place, reptiles do not require as much air as birds and mammals, and in the next place, the lungs of the snakes are formed in a very remarkable manner. Only one lung is developed for use, and that is a nearly cylindrical sac of considerable length, only the upper part serving the office of a lung, the rest being simply a reservoir of air. The snake, therefore, can exist for a long time without needing to take a fresh supply of air. Keep this structure in mind, as it has a very important bearing on the life-history of the whole snake tribe.

The manner of taking food is always an important element in animal life, especially when it is shared by an entire group. Now, all snakes, when once their jaws have closed upon the prey, swallow it in the same manner. The grass-snake feeds almost exclusively on frogs and newts, and its mode of swallowing the frog will teach us the wonderful mechanism by which a snake is able to swallow entire an animal four or five times larger than the throat through which it has to pass.

For a man to swallow a sheep whole would be an analogous task.

We all know that the mouth of a snake is very wide, but when we are told that a grass-snake is about to swallow a frog, whose head alone is much larger than that of the snake, we should be apt to say that such a feat must be impossible. How can the snake get into its mouth a frog many times larger than the whole of its head?

Look at the accompanying figure of the rattle-snake skull. Notice, in the first place, that all the teeth point backwards. Next, trace the lower jaw backwards, and you will see that it is not jointed directly to the skull, but to a long, straight bone, which forms a connection between the skull and the jaw, and which therefore allows the jaw



SKULL OF RATTLE-SNAKE.

to be opened to an enormous extent. This, however, is not all, for the bones of the skull and two halves of the lower jaw are not firmly united, as with the higher animals, but are only kept together by elastic ligaments, so that they can be pulled asunder without doing any harm.

Now let us see how a snake eats a frog. Do not be carried away with the natural but really thoughtless idea that there is any cruelty involved. To do so is a reflection on the goodness of the Creator, who has appointed that one set of animals should feed upon another set, as they have done countless ages before man could have lived on the earth. When a frog finds itself chased by a snake, it seldom tries to escape, but gives a peculiar

cry, and resigns itself to its fate. I have several times witnessed the process, which is almost invariably as follows: The snake seizes the toes of a hind-leg, and presently the legs seem to slide down the snake's throat, with a very slow but regular movement. How is this done? The upper jaw remains fixed, but the lower jaw is kept continually moving forwards and then backwards. Now, as both jaws are fitted with pointed teeth directed backwards, it is evident that any object which is held between them must be gradually drawn down the throat.

Here is the head of a non-venomous snake, showing



SKULL OF PYTHON.

the structure of the teeth and jaws. The head is that of the boa-constrictor, but that of the common grass-snake is almost identical in structure, really the only difference being that of size.

At last one leg is swallowed, but the other remains free, and apparently out of the snake's power. Presently, the frog, finding its leg fixed, tries to free itself by pushing the snake away with the free foot. The consequence is that the second foot is caught, and soon follows its fellow-limb, until both legs have passed down the

snake's throat. The body of the frog now becomes practically a wedge, which, as it passes downwards, forces asunder the bones of the head, and stretches the skin of the head and neck until it becomes a thin translucent membrane, with scales set upon it at rather distant intervals.

By degrees the head loses all semblance of its original form, its various portions being spread, so to speak, over the body of the frog. The snake, in fact, is literally 'putting itself outside' its food. During this process, the windpipe, by which air passes into the lungs, is squeezed quite flat, so that respiration is impossible until the frog has passed into the stomach. Now we see the use of the reservoir of air in the long bag-like lung. It is for the purpose of supplying air to the system during the space of time which is occupied in swallowing prey.

Gradually the frog passes through the neck into the stomach, which, together with the skin which covers it, is extremely elastic, and allows a vast amount of distension. As soon as the bones of the skull are relieved from the separative pressure of the frog, the elasticity of the connecting ligaments and skin draws them together again, and in a wonderfully short time the head and neck resume their wonted appearance. The swallowed frog is very perceptible as a large lump near the middle of the body, gradually disappearing as it is digested.

I have seen the grass-snake eat the common newt, and in that case it always swallowed its prey head downwards. In order to prevent mistakes, I will here mention that in the case of venomous snakes the poison-fangs take no part in the process of swallowing food, but are folded back, so as to escape injury. The eggs

of the grass-snake are about as large as ordinary grapes, whitish in colour, soft-shelled, and attached to each other, end to end, by connecting membrane.

When I was a child at Oxford, I was very familiar with the grass-snake and its eggs. Behind the stable was a rather deep, brick-lined pit, into which were thrown all the fallen leaves and other *débris* of a garden, for the purpose of making leaf-mould for flowers. The partial decomposition which takes place under such circumstances produced much moist heat, and the pit was, therefore, a favourite spot in which the snake laid its eggs. This was the more remarkable, as the garden upon which the stable opened was surrounded with a brick wall, which must have been climbed by the snakes before they could reach the pit. The wall was a very old one, the interstices between the bricks having been much enlarged by many successive sets of nails, so that the surface, though perpendicular, was sufficiently rough to allow the horny bands to find a hold.

Although this snake has no poison-fangs, it has one means of defence in a most abominable odour, which it exhales when alarmed, and which clings so persistently that it can with difficulty be removed. That the odour is intentionally produced is shown by the fact that when the snake is tamed it allows itself to be handled freely, and without any unpleasant results. The same fact has been noticed in the case of tame weasels.

Like our other reptiles, the grass-snake is a hibernator, retiring to a hole in the ground at the end of autumn, and not making its appearance until the spring is far enough advanced to bring out the frogs on which it feeds. Great numbers of snakes will sometimes resort to

the same hibernating retreat, and very few years pass without notices in the newspapers of these wintry gatherings. Unfortunately, the discoverers are mostly field-labourers, who come upon the retreat while cutting into a bank. Thinking that a snake must necessarily be poisonous, they invariably kill all the torpid reptiles, and think that they have performed a most praiseworthy feat of valour.

Before parting with our grass-snake, let us examine the long, forked tongue, which is so persistently called a 'sting.' Here again artists and taxidermists are almost invariably at fault. They persist in representing every snake with its mouth wide open, and a flat, forked tongue proceeding from the very back of its throat. Now, the tongue of any snake, whether poisonous or harmless, is nearly cylindrical, and proceeds from a fleshy tube at the end of the lower jaw. Moreover, it is often protruded when the mouth is only opened wide enough to allow it to pass between the lips. It is, in fact, the snake's only organ of touch, and is applied to every object which the reptile wishes to examine.

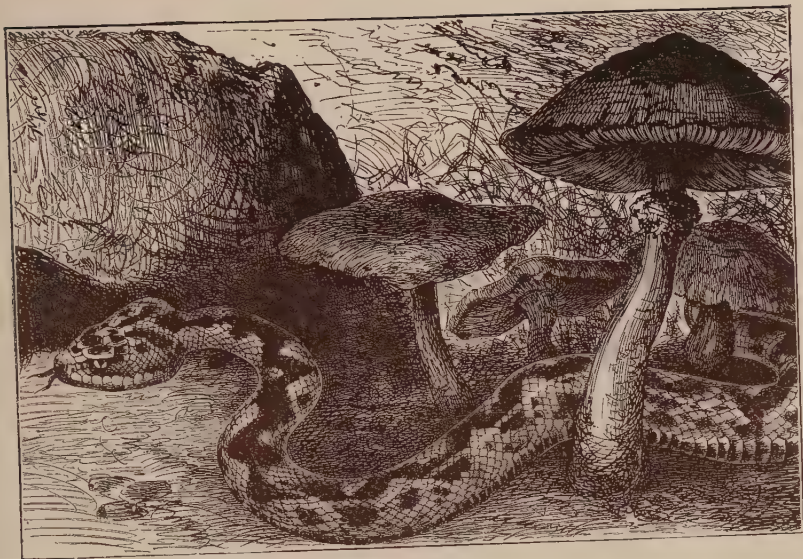
While passing through underwood or thick herbage the snake makes a slight but characteristic rustling sound. One of my pupils had a wonderful ear for a snake. While walking along the road I have more than once seen him suddenly stop, listen for a moment, jump into the ditch that bordered the road, and then jump back again, holding a snake in his hands. In fact, nearly all the snakes in the school were captured by him.

CHAPTER XXII

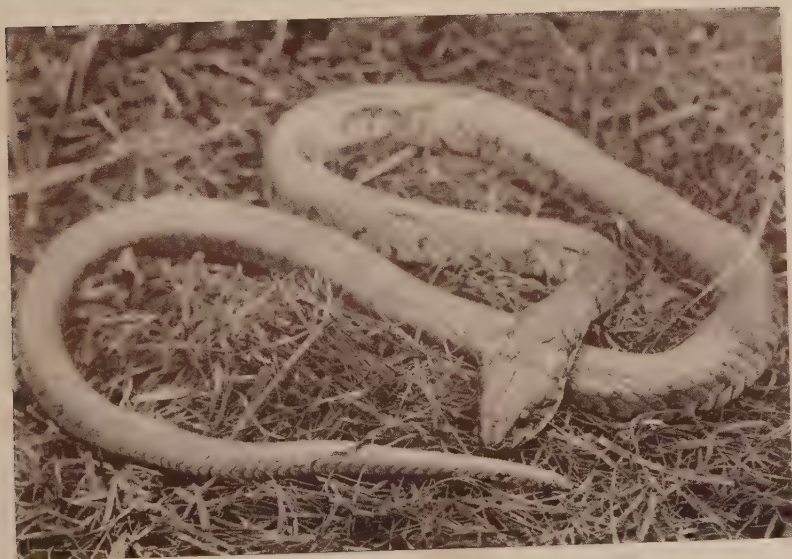
THE VIPER (*Pelias berus*)

MOST persons, even if they saw a grass-snake, would be afraid to handle it, lest it might be a viper. Now, there is not the least resemblance between the two snakes. The colour of the grass-snake is grey above, tinged with green, and there is a patch of yellow on either side of the head at its junction with the neck. Behind the yellow comes a patch of black, and some rows of dark spots run along the body. The lower surface is black, sometimes tinged with blue. The head is long and narrow, and the scales upon its upper surface are large.

The viper presents a complete contrast in every particular. Its colour is extremely variable, and I have seen grey, brown, chestnut, greenish yellow, and nearly black vipers. The last which I saw alive, and which was captured in Cannock Chase about six months before writing these lines, on the bank of a little fast-flowing brook, was dark brownish red, and so agile that several times it all but escaped us. At last it became quite tired from incessant disturbance, and allowed itself to be guided into an insect net which was held in front of it. A string was then tied above it, and it was carried off in triumph.



The Viper.



The Grass-snake.

Whatever may be the colour of the viper, there are three distinctive points by which the snake can be recognized. In the first place, the head is short, very wide at its junction with the neck, and the scales of the head are small. Upon the upper surface of the head is a bold black mark shaped like the letter V, and really looking as if it were the initial of the animal. The third point is, that along the spine runs a sort of zigzag chain of squared black marks, which cannot be mistaken. It is a much smaller reptile than the grass-snake, seldom exceeding two feet in length, while the grass-snake is often more than a yard long.

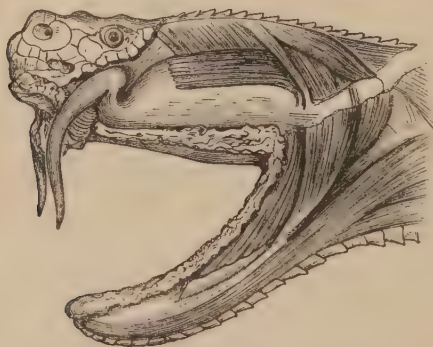
But the chief distinction lies in the head, which, as already stated, is very wide at the junction with the neck, the reason for which we will now see.

There is a celebrated definition of snakes by a school-boy. 'Snakes,' he wrote, 'are of two kinds. Some are venomous, and the others don't.' His definition was better than his grammar, for snakes can be broadly divided into those which do and those which do not possess poison-fangs. Refer to the skull of the rattlesnake, and you will notice that nearly at the end of the upper jaw two very large fangs are placed. These are the means by which the poison is conveyed into the body of the victim. They do not remain permanently extended, as shown in the illustration, but when not in use are folded back, so that when the jaw is partially opened they would not be seen by any one who was not familiar with them.

They are hollow from the base nearly to the tip, where a small aperture permits the liquid poison to escape.

The structure by which a venomous snake strikes its prey may be at once seen by reference to the illustration, which represents a head partially dissected. It is that of the rattle-snake, but is identical with that of the viper. At each side of the head there is a large sac or reservoir of poison, and it is to make room for this reservoir that the head of a venomous snake is always widened at the base.

From the front of this sac proceeds a flexible tube



SECTION OF HEAD OF RATTLE-SNAKE.

connected with the hollow base of the fang. As you may see, when the fang is not in use and is folded back against the upper jaw, the tube is mechanically closed, so that none of the poison escapes. But when the fang is thrown forward for action the tube is opened in readiness for the passage of the venom.

I may mention that the mere fact of opening the mouth does not erect the poison-fangs, which are worked by separate muscles of their own, and can be

folded or erected at will. This faculty is especially needed in swallowing prey, in which action the jaws must be opened to the fullest extent. Otherwise the fangs would be broken off long before the prey had passed through the mouth. They are not even set directly in the jaw, like the other teeth, but are only attached by strong ligaments. Under any circumstances, when a powerful animal is attacked and tries to escape, its struggles, brief though they must be, will sometimes tear the fang from the jaw, thus depriving the snake of its weapons. So, just as is the case with the shark's teeth, there are several sets of fangs, diminishing gradually in size, and lying behind each other in the jaw. I have dissected the heads of many vipers, and always found four sets of fangs, the first being fully developed in the front of the jaw, and the others lying in the jaw, the last being no larger than a very fine needle, and quite transparent.

But how is the poison injected so suddenly into the wound? This query can be answered by reference to the illustration. It will be seen that a number of muscular bands pass over the reservoir, so that by their contraction the liquid is violently squeezed through the duct into the hollowed tooth, and thence through the aperture near the tip.

In South Africa there is a kind of cobra called by the Boers the 'Spugh-slange,' *i.e.* the Spitting-snake, which can eject the poison to a distance of some feet. The colonists say that it aims the poison at the eyes of its adversary, and it is certain that many persons have been nearly blinded by receiving the poison in the eye. I am, however, inclined to think that the snake makes a futile

dart at the face, and that the poison is ejected before the stroke has been completed.

Like other venomous snakes, the viper is in no hurry to use its fangs, and, I believe, never does so except to procure food, or in self-defence after much provocation. Our viper in Cannock Chase at last kept itself in the attitude of menace, and wherever it went the neck was curved and the head drawn back ready for a stroke. But it was much too wise to strike at the sticks which were continually driving it from its shelter, though I have no doubt that if a hand had been placed within reach the reptile would have struck effectively enough.

I once noticed a similar instance of discrimination when I was in the New Forest. A viper had been so severely injured by a blow on the back from a stick that it could not crawl away and escape. But it held itself ready to strike at any enemy that might come within reach. Nothing, however, could induce it to bite a stick, but a kitten having been attracted by curiosity, the viper struck at it at once, and had it not been too much disabled to make its usual stroke, would probably have killed the animal.

Nearly as many legends prevail regarding the viper as those which relate to the toad and newt. The fat of the viper, for example, is in many country places thought to be an effectual cure for sprains and bruises, and a certain remedy for the viper's bite. Accordingly, viper-catching was at one time a profitable trade, as even the regular practitioners believed in the virtues of viper fat and viper oil, and were constant customers of the viper-catchers.

Another celebrated product of the viper is the 'sheath-stone,' one of which every viper is supposed to produce

annually. The old Welsh sexton, to whom reference has already been made, was full of stories respecting the sheath-stone and its many virtues. He described the stone as 'the most handsomest thing you ever saw,' resembling a snake congealed, and able to cure a viper's bite on the spot. While the viper is making the stone, it sings just like a canary, and the sexton averred that his grandmother was once attracted by some beautiful music in the woods, and, when she came to the spot, found it was produced by thirty vipers, all at work on one stone.

Then, he had an extraordinary tale about the poison of the viper, asserting that it was kept in a long black bag, which the viper always carefully laid aside before it entered water, and then picked it up again when it came to land. He told Dr. Sneyd-Kynnersley that he had picked up the bag in the churchyard, and stated that if the viper lost the bag it pined away and died.

Here I may mention that the viper seldom if ever enters the water voluntarily, like the grass-snake, and if thrown into water seems quite bewildered before it makes up its mind to swim.

Another legend of the viper may be found in Pepys' diary. It is to the effect that vipers are very fond of skylarks, and that when they hear a lark in the air they crawl under it with open mouth, 'and there, as is conceived, they do eject poyson upon the bird, for the bird do suddenly come down again in the form of a circle, and falls directly into the mouth of the serpent, which is very strange.' (*Diary*, Feb. 4, 1661.)

Now we come to a rather important question : Ought vipers to be killed whenever they are found ?

I think that the verdict would be almost unanimously in the affirmative. For my part, I have many doubts on the subject. The viper never assaults a human being unprovoked; and as to its dangerous qualities, our records show that many more people die from the stings of bees than from the bites of vipers.

When first I went to stay in the New Forest, I was rather nervous about the vipers, which simply swarm there. In some spots, on a hot summer's day, it is hardly possible to take three or four steps without seeing a viper gliding away. Not having leathern gaiters with me, I could not but walk very cautiously, for fear of treading on a viper. But the vipers were even more wary, and at the approach of a human footstep retreated among the sheltering herbage. After a day or two, I entirely lost my nervousness, and cared no more for the vipers than if they had been so many earthworms.

Then, by destroying every viper that is met we disturb the balance of Nature. The chief food of the viper is the field-vole, and when we kill the viper we are removing one of the deadliest foes of the destructive rodent, and are acting as foolishly as we do when we shoot the kestrel and the owl. I would never kill a viper except for some definite purpose, and would prefer to let it carry out the life-work for which it was intended.

The viper also feeds on nestling birds, and will climb trees in order to reach them; but its ordinary food is the field-vole, and its services in reducing the numbers of that destructive little animal are of no small value.

It is not at all likely that any of my readers will be bitten by a viper, but, should such a misfortune occur,

there is no need for alarm, especially for a person in good health. No one thinks of any danger attending the sting of a bee. There is pain, more or less severe, but it soon goes off, and there is an end of it. Yet I have before me printed accounts of four people being killed, within as many years, by the sting of bees. The remarkable point is that in no instance was the wound in a dangerous spot. The worst case was that of a farmer who was stung by a single bee on the forehead, and died almost immediately.

As to remedies, it is not likely that any could be found in places where vipers live ; and before a chemist's shop could be reached the poison would have mixed with the blood, and the mischief have been done. I know several persons who have been bitten by the viper. There was great pain, much swelling of the wounded limb, and in one case fever and faintness for several days.

The viper does not lay eggs, like the grass-snake, so that if such eggs should be found, there is no fear that vipers should be hatched from them. As soon as the little vipers appear in the world, they are as lively and self-possessed as newly hatched chickens, and strike as fiercely at any fancied foe as if they had enjoyed a long experience of life.

CHAPTER XXIII

GENERAL STRUCTURE OF FISHES

AT present, the only fish with which we have dealt is the pike, and even that fish was simply mentioned as the destroyer of the water-vole.

Bear in mind that this work has nothing to do with the capture of any creature by way of sport. Occasionally it will be necessary to take an inhabitant of the brook or the bank in order to elucidate its life-history, but except for such purposes I do not wish the subjects of our investigations to be even bereft of their liberty, still less to be deprived of their life.

As the brook is sure to contain a variety of fresh-water fish, I will restrict myself to the life-history of one little group, giving a casual glance at one or two other species as they are required for the elucidation of the subject.

Following the plan which I have pursued through this work, I will first devote a few lines to the general structure of fishes as a class, before describing any particular species. The skeleton of the common perch affords a very good type of fish structure. At first sight it looks exceedingly complicated, but is in reality much simpler than it looks, and is easily analysed. Begin at the head, and you can trace the vertebræ of the spine

as they run along the centre of the body, until they are merged into the double tail-fin. But what are those long, pointed bones which run in a line with the vertebræ, but are not connected with them? What are the bones which are jointed to the front part of the skeleton, and look as if they grew out of the head? We will take these latter bones first. They are the analogues of the limbs of the higher vertebrates, but are constructed in a manner which at first seems rather strange. We are always accustomed to think that the fore-limbs of any animal ought to be in front of the hind-limbs. Suppose, for instance, that we were to see a horse with its hind-legs proceeding from its breast, we should think it a very strange kind of horse. It would be a still more abnormal animal if the hind-legs were actually in front of the fore-legs. Fishes, however, are not bound by any such restrictions, but carry their limbs just where they can best serve their purpose.

The fan-like group of bones are the bones of the left fore-limb, corresponding with the arm of man and the wing of the bird. They are called collectively the 'pectoral fin,' and in some species, such as the flying-fish and the gurnards, are enormously developed; in others, such as the climbing-perch, they are not only the analogues of the fore-legs, but are actually used for walking on dry land.

Below the pectoral fin is another group of bones. These are called the 'ventral fins,' and are analogous to the hind-legs. On looking at the skeleton, you will see that they are actually jointed in front of the fore-legs, thus producing an apparent monstrosity. Only a portion, however, of the limb protrudes from the body, so that

the external appearance of the fish is as here shown, few persons recognizing the true nature of these fins.

Now we come to the fins which are not connected with the spine. One set of these fins runs along the back, and is known as the 'dorsal fin,' about which we shall soon have something to say. Then comes the 'anal fin,' on the lower surface of the body, and lastly comes the double tail-fin.

As to their respiration, the true fishes breathe by means of gills, which are situated at the sides of the head in most cases, and in the typical fishes are protected by gill-covers. When breathing, the fish receives water into its mouth, but, instead of swallowing it, forces it out at each side, so that it passes over the gills, and thus aerates the blood. But it swallows none of the water, so that the well-known phrase, 'drinking like a fish,' is altogether erroneous. As in the tadpole, the gills are supported on an elaborated development of the hyoid bones.

Sticklebacks.—Now we will trace the life-history of almost the only group of fishes which can be said to possess a life-history. Very few of the fish tribes do anything except seek for food. The common gold-fish, for example, continually swims about, and is very graceful and ornamental. Setting aside its beauty, it is a perfectly uninteresting fish, and little is to be gained by watching it. But there is one group of fishes which are not only the equals, if not the superiors of the gold-fish in beauty, but possess a life-history which is full of an almost human interest.

They have a wider geographical range than any other

known fish, being found in almost all waters, whether fresh, brackish, or actually salt. They are called by the very appropriate name of Sticklebacks, and are scientifically grouped under the name of *Gasterósteus*. This name is compounded of two Greek words, literally signifying 'bone-bellied,' and is given to the group because their bodies are not furnished with scales, as is the case with most fishes, but are partially defended by bands of horny matter, very much resembling, both in form and office, the iron bands of the armour for the arms and legs in use in early Stuart times.

There are several species of stickleback in English waters, and I shall therefore take as the typical species that which is popularly known as the three-spined stickleback, and scientifically as *Gasterósteus aculeátus*. It has many local names. One of the commonest is tittlebat, which has been immortalized in the opening chapters of *Pickwick*. Sometimes this word is contracted into tittler, and another popular name is 'Jack Sharp.' All these names are given to the fish on account of the remarkable manner in which the pectoral and dorsal fins are converted into weapons so formidable that not even the pike dares to attack a stickleback.

Beginning with the dorsal fin, we shall see that it is divided into two distinct portions. That which is nearest the tail has its rays soft and jointed, while the front portion is reduced to three rays, without any connecting membrane. In them, however, seems to be concentrated all the strength which would have belonged to the missing portions, the rays being exceedingly stout, sharply pointed, and capable of being raised or depressed at will.

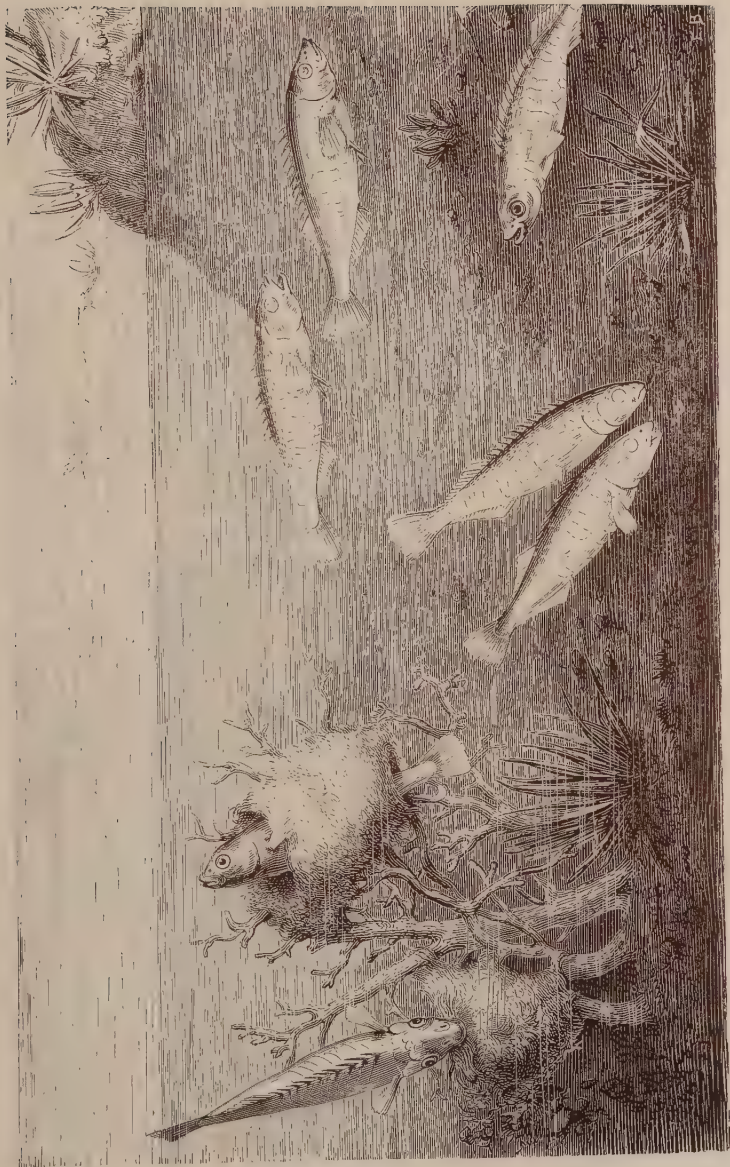
The number of horny rays depends on the species.

A very common species, such as is represented in the illustration, has ten rays, while another has only two, and a third, which inhabits the sea, has fifteen.

This concentration of strength is even more strongly carried out in the pectoral fins, each of which is reduced to a single but very strong ray. This also can be raised or depressed at will, and is the principal offensive weapon, the dorsal spines being chiefly useful for defensive purposes.

As a general rule in zoology, although the male is the handsomer of the two sexes, the chief life-interest centres in the female, who does all the work, while the male scarcely works at all. In fact, their conditions of life are almost exactly those of the savage, who, no matter what may be his race, never condescends to do a stroke of work, leaving all labour to his wives. But the male stickleback is an honourable exception to the general rule, and in almost every respect is a pattern for his sex to imitate. Not only is he, by virtue of his sex, handsomer than the female, but he is infinitely the more interesting of the two. The female is not only dull of colour, but she is absolutely uninteresting, only ceasing to be a nonentity when she becomes an active nuisance.

During the greater part of the year, both sexes are of a simple greyish-brown, and are so much alike that it is very difficult to distinguish between them. But towards spring the male literally begins to show himself in his true colours. We are told that 'in the spring a young man's fancy lightly turns to thoughts of love'; and the same rule applies to the stickleback. Somewhere about March, the male stickleback thinks 'that he ought to be taking a wife,' and, like other male animals, he



Ten-spined Sticklebacks and their Nests.

betrays his thoughts by a great improvement in his personal appearance. First his eyes become green—a peculiar and almost opalescent green. Then the whole upper parts of his body assume a brilliant green hue, while the lower surface becomes bright scarlet.

Meanwhile, he, being, as I have said, a credit to his sex, has been busily engaged in preparing a home for his bride. He is one of the very few fishes which are gifted with the power of building houses. As he has nothing but loose vegetable fibres by way of materials, and nothing but the slime which exudes from his body by way of mortar, no great strength can be expected from him. As, moreover, he has no tools except his mouth, it is evident that architectural skill is almost impossible. However, he does his best with the very limited means which he has at his command, and very interesting it is to see him at work.

The character of the nest depends much upon the soil through which the brook runs, and the swiftness of the stream. Should the soil be clay, and the stream sluggish, the bed is sure to be largely composed of mud. In that case, the stickleback simply scoops a hole in the mud, using his lower jaw as a shovel, and then roofs the cavity with fibres. But if, as at Oxford, where, when a very tiny boy, I first studied the habits of the stickleback, the stream is somewhat swift, and its bed is gravel, the stickleback's powers are tested to the utmost.

He begins by cruising about until he finds a fibre which will suit his purpose. Bearing it in his mouth, he takes it to the selected spot, and twists it among the stems of aquatic plants or any similar support. About Oxford, the banks of the Isis, Cherwell, and their

numerous tributaries are fringed with willow trees. Now the roots of the willow have a special love for water, and when they grow near a brook always drive their fibres into the water. These roots look very much like enormous fox 'brushes,' the fibres, or rootlets, being very slender, very long, and of a brick-red colour. These roots are favourite nesting-places for the stickleback, as the fibres can be twisted in and out of them without much difficulty. Moreover, the dense mass of rootlets acts as a shelter for the nest, which, as we shall see, needs every means of defence that can be found.

At first, it is not very easy to see what the stickleback is doing. He brings a long fibre in his mouth, and twists it, apparently at random, among the rootlets. Then he goes off, fetches another fibre, and acts in the same manner. At last his ideas begin to assume definite form. It is a slow process, because suitable fibres are scarce, and can only be procured after long searching and fierce competition on the part of other male sticklebacks who are abroad on the same errand. In fact, before a stickleback can finish his house he has been repeatedly obliged to prove that he can not only build a house, but hold it against all comers.

When completed, the house is of the simplest character, even surpassing in this respect the celebrated tub of Diogenes. It is shaped very much like a barrel from which both ends have been removed, and is not quite half as long as the bride for whom it is intended. Still, it is quite sufficient for its object.

Having finished his house, the stickleback goes off in search of a wife. Owing, perhaps, to his gorgeous costume, he never has to wait, but brings a wife home,

and with some amount of persuasion, sometimes amounting to force, induces her to enter her new home. Her stay is not long, as she only has one office in life—*i.e.* to deposit her eggs in the nest. As the eggs are very large in proportion to the fish, they are necessarily few in number. Now, the chief object of the male stickleback's life is to bring up a large family, and when he finds that his wife can lay no more eggs, he turns her out as useless, enters the nest himself, and arranges the eggs in order. He then goes off in search of another wife, and instals her in the place of her predecessor, repeating the process until he is satisfied with the number of eggs. He then closes the nest, and mounts guard over it. He does so in a very literal manner, poising himself above the nest, and never leaving it for a moment. It is necessary that he should do so, for the nest is always surrounded by foes, the most persistent of which are the discarded wives. They are always hanging about the nest, not impelled by maternal anxiety for their offspring, but urged by desire to eat either the eggs or the newly hatched young.

On one occasion the male was removed, by way of experiment. Scarcely was the watchful sentinel out of the water, before a crowd of sticklebacks assailed the nest, and began to tear it to pieces, for the sake of getting at the eggs. He was then replaced in the water, and at once charged the robbers, dispersing them in all directions. Having driven away the enemies, he set to work at repairing the damaged nest, and when he had completed the task he resumed his post as sentinel.

For at least a month he hangs over his nest, until the eggs are hatched, and does not allow any living creature

to enter an imaginary cordon about a foot or so in diameter. Not even the pike or perch dares to attack a stickleback, knowing well the power of the two ventral fins, not to mention the sharp spines of the dorsal fin.

Sometimes another male stickleback intrudes within the sacred precincts, and is instantly assaulted. Mostly, the trespasser accepts the warning and makes off, but now and then he prefers to fight. When this is the case, the combat is a singularly interesting one. The two antagonists face each other, with their ventral fins projecting as far as possible from the sides. For a little time they dodge round and round like two boxers or fencers, watching for an opening. Suddenly one of the combatants dashes at the other, trying to rip him up with a ventral fin, and, if he should succeed, killing him on the spot. Mostly, however, the intruder, after a few skirmishes, makes off, leaving the rightful owner in possession of his property.

A remarkable change now takes place in both the fishes. The vanquished stickleback almost immediately begins to lose his lovely colours, and, before long, resumes the grey and brown hues of ordinary life. But the victor glows with double radiance. He seems as if his body were made of mother-of-pearl, ruby, and emerald, illumined with an internal lamp. No colours that man has invented or artist used can do more than feebly indicate the astonishing beauty of a stickleback who has either killed or driven away an invader of his home.

At last the eggs are hatched, and the young emerge into the nest. It is not easy to see them, as they are tiny beings, and their bodies are quite translucent. The eye, however, is always dark, and by it the young can be

detected. For some time the father keeps them inside the nest, but when they have gained sufficient strength, he allows them to leave the narrow precincts of the nest, and to swim about within the cordon which he has guarded with such jealous care.

Now and then an adventurous infant breaks bounds, and tries to make its way into the world. The father puts a summary stop to such disobedience. He dashes after the offender, and drives it back by blowing mouthfuls of sand or mud at it. Should it still persist, he catches it in his mouth, brings it back, and literally spits it into the nest. There he keeps the delinquent, like a naughty boy in a corner, until it has learned better manners. At last, when the young are strong enough to shift for themselves, he goes off guard, and permits the young to wander where they like. Having now fulfilled his duty, his colours rapidly fade, and will not be resumed until the following spring.

I hope that my readers will not deduce from this little life-drama the moral which was drawn by a boy not long ago.

I was delivering a lecture on this subject, and a school-master thought that it would afford an agreeable variety to the ordinary routine of lessons. So, instead of setting a theme for the usual lesson in composition, he took his boys to the lecture, telling them to take notes, and then to write an account of the lecture. One of these essays was so characteristic that the master sent it to me. It consisted of two sentences, and ran as follows :

‘The stickleback is a most interesting animal. He kicks out all his wives.’

CHAPTER XXIV

THE STICKLEBACK IN THE AQUARIUM—THE ARGULUS

ALTHOUGH you can watch the stickleback in his own domains, it is better to have him under your own eye, and watch him at home. He is a wonderfully hardy little fish, and, if proper care be taken, will live for a long time in captivity. I have seen one which had inhabited the same vessel for eight years. He was the only inhabitant, having by degrees killed all his companions.

You will naturally wish to secure the strongest specimens, and may as well make use of a plan which I invented some years ago, forcing the sticklebacks to make their own selection. Take a wide-mouthed bottle of white glass, and cut off the bottom. This is very easily done without the use of a diamond. With the edge of a file, you cut a notch in the glass. Then heat a poker red-hot, and put one angle into the notch. Hold it there for a second or two, and then draw the poker slowly round the bottle. A slight crack will follow it, and if you tap the bottle smartly the bottom will fall off.

Now tie a piece of string across the mouth of the bottle, and fasten a long thread to a stick. Take with you a can in which to put your fish, a fine-meshed

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net, a long piece of string, and a forked stick, and you will be ready for action. Always, if possible, procure your sticklebacks from a stream, as they are generally stronger and more brilliantly coloured than those which live in still waters. Having found a suitable spot, dig up a worm, and tie it by the middle to the thread, so as to hang inside the bottle. You need not hurt it, and when you have done with it you can replace it on the ground none the worse.

Now, by the aid of your forked stick and the string, lower the bottle gently into the water. The sticklebacks will soon be attracted by the worm, and will dash at it. They always knock their noses against the glass, but they never learn wisdom by experience, and return to the charge again and again. Others are attracted by their movements, and before long the bottle will be surrounded by an eager crowd of sticklebacks. They then begin to fight with each other for the best places, and before very long the strongest will have driven away the weakest, thus making their own selection.

Now raise the bottle to the surface of the water, and if this be done gently, the sticklebacks will follow it without taking alarm. You can then slip your net under the fish, and will capture twenty or thirty of the finest specimens in the stream. Pick out the largest male and six or seven females, return the rest to the stream, and bring your captives home.

Take care to have the bed of your tank covered with well-washed gravel or other stones, and fasten among the stones the roots of almost any aquatic plant, such as the common anacharis, or, better still, the vallisneria,

which can be procured for a few pence. Then, if you supply him with fibres of almost any material and colour, the male will weave his nest with them before your eyes. Silk fibres are preferable to those of any vegetable matter, as they do not float, and therefore the stickleback has little trouble in bringing them below the surface.

Take care that there is plenty of surface of water for absorbing the oxygen of the atmosphere. Almost any vessel will answer as an aquarium, provided that it has a wide absorbent surface. The high narrow aquaria which are furnished by unpractical dealers are exceedingly troublesome owing to the difficulty of supplying the inmates with oxygen. A sure indication of insufficient oxygen is given by the behaviour of the fishes. As long as they remain well below the surface, swimming quietly backwards and forwards, all is well. But if you see them keeping near the surface, and continually gulping at the air, you may be sure that the oxygen of the water is becoming exhausted, and unless you take means to restore it you will find your fishes floating on their backs in a dying state.

Should your aquarium be of this character, you can apply a simple but effectual remedy without much trouble, and at very little expense. If you soak in water a loosely twisted string, put one end into the aquarium, and allow the other end to hang below the vessel, the string will act as a siphon, and draw out the whole of the water, drop by drop. By taking advantage of this property, you can easily keep the water of your aquarium in a healthy condition. Hang a wet string into it, so as to drain off the water into

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a vessel below. Then place above the aquarium a vessel supplied with water, and fitted with a similar string, so placed as to allow the water to drip into it from a height, and so to drive air into the water. The same water may be used over and over again, and in this simple way your fishes will be preserved in health.

In any case, it is as well to procure a common glass syringe, such as can be purchased for a few pence at any chemist's. Keep it by the aquarium, and whenever you are passing near it fill the syringe with water, and squirt it sharply into the water from the height of a foot or so, thus driving a column of air-bubbles down to the bottom of the vessel, and allowing the water to absorb the oxygen contained in them. Still, if you have a wide vessel, so that a large surface of water is exposed to the air, you need not trouble yourself, as the water will absorb sufficient oxygen to sustain the respiration of the fishes.

Before concluding this history of the stickleback, I must express my wonder that in this country we make no use of this valuable little fish. On the Continent it is appreciated to the fullest extent. Like the sprat and many other fishes, it is of an oily nature, and is therefore netted in vast quantities, and the oil extracted by pressure, a bushel of sticklebacks yielding about a gallon of oil. After the oil has been extracted, the solid portions of the fish are compressed into a kind of cake, which is found to be very useful in fattening pigs and poultry.

Moreover, the stickleback is very good to eat, and if cooked like the whitebait cannot be distinguished from

that fish—or rather that mixture of fish. Indeed, I have no doubt that now, as used to be the case many years ago, the stickleback is actually consumed as whitebait.

When I was an undergraduate at Oxford, there were a few water-side families who made a dishonest living by poaching upon the rivers. Among other devices, they used at night to drag the Isis, Cherwell, and their many tributary streams, with nets having meshes far smaller than the legal dimensions. Their principal captures were the fry of the roach, perch, minnow, dace, and bleak, all of which fish simply swarm in those waters. Beside these, they caught enormous quantities of sticklebacks, and sent their captures up to London, where they were bought and consumed as whitebait.

So far, then, the stickleback may take rank as a distinctly useful fish. Is there an opposite view to be taken, and does the stickleback do any harm? It has been accused of eating the eggs of the perch and other river fishes, but I very much doubt the truth of the indictment. Even if it did so, it could do but little harm. The stickleback is a very little fish, and although fish can swallow an amount of food which seems utterly disproportionate to their dimensions, it can make but slight impression on the vast quantities of ova which are deposited by the fish whose eggs it is said to destroy. Now, the perch lays about two hundred and fifty thousand eggs, while the carp tribe, to which the roach belongs, lay, on an average, about two million eggs. It is very clear, therefore, that the stickleback may be acquitted of the accusation of limiting the numbers of other fishes that inhabit the brook.

Sometimes it certainly has a habit of getting into places where it is not wanted. For example, being almost as irrepressible as the sparrow, it insists on making its appearance in the reservoirs of the London water companies. This, however, is from no fault of its own, it being drawn through the pipes without any power of resistance. By similar means it is delivered into private houses, and sometimes makes its appearance where it is least expected. An amusing example of this proclivity is given in the biography of Frank Buckland.

One morning, at breakfast time, the mistress of the house was pouring some milk into a cup, when a lively stickleback flopped into the cup. The master of the house snatched up the cup and carried it off to the purveyor of milk, asking him what he meant by *that*! Being taken by surprise, he turned upon the foreman, and rated him for not having strained the water! So, in this case at least, the intrusion of the stickleback was decidedly beneficial to man.

I CANNOT finally dismiss this wonderful little fish without a passing reference to a creature with which it is intimately connected.

Formidable as is the stickleback to most inhabitants of the water, it yet has its foes against which it is powerless. One of the worst of these enemies is the very remarkable creature scientifically known as *Argulus foliaceus*. As you are watching the sticklebacks in your aquarium, you will be sure, sooner or latter, to see a singular little object swimming about without any apparent purpose. It is green in colour, quite flat, oval in shape, and about

as large as the capital letter O. It looks very much like a piece of green leaf swimming about without apparent means of locomotion.

Now we shall see the meaning of its scientific name. As all students of ancient mythology are aware, Argus was a man possessing a hundred eyes, so that some of them were always awake. Being jealous of the nymph Io—and with good reason—Juno set Argus to watch her day and night. Mercury, however, by means of the lyre which he invented, succeeded in soothing to slumber all the eyes of Argus, killed him, and set Io free. As a perpetual remembrance of his death, Juno took his eyes and set them in her peacock's train. The name of *argulus*, or little Argus, has been given to this creature on account of its resemblance in form and colour to the 'eyes' of a peacock's train.

The specific name, *foliaceus*, signifies leaf-like, and is given to this species partly on account of its leaf-like flatness, and partly on account of its green colour.

After swimming about aimlessly for a while, the *argulus* makes for one of the fish, always from behind, and then seems to vanish.

Catch the creature, and examine it with a magnifying glass, and you will see that the under surface presents a most remarkable appearance which words can hardly describe. The upper surface is simply flat, and presents nothing which is worth the trouble of examining. The *argulus* is a crustacean, a kind of fourth cousin of the shrimp, and presents many points of interest. Beginning at the wider end, there are four pairs of jointed legs, each furnished with a tuft of bristles at the tip. These are the paddles by means of which the *argulus* rows itself

through the water with such activity that the stickleback is helpless against its assaults. Next come two pairs of strong, jointed hooks, and just above them are two circular objects, looking like little wheels. In the centre of the body, just above the wheels, is a sharply pointed beak, which, when the creature is viewed edgewise, is seen to project from the body like a bayonet.

Now let us investigate the details of the argulus. In all the crustacea there is a normal number of legs. Some of them are greatly developed, others are sometimes so small as hardly to be recognized as limbs, while others again are wonderfully modified, so as to fulfil the most opposite offices. If any of my readers would like to study this subject more deeply, I strongly recommend them to work at Huxley's monograph on the crayfish. It is tough, and requires a good deal of Greek lexicon, but will more than repay the trouble.

Nowadays every one seems to learn Greek—and a very good thing too, if only to read the New Testament in the original. But if you should not understand the rudiments of the language (very little more is needed), get some competent person to make a literal translation of the difficult words, and you will soon find that the book is perfectly easy of comprehension, and as absorbingly interesting as a fairy tale.

In the argulus, eight of the limbs (we will not call them legs) are exclusively used as oars. This structure is found in many other allied species, all of which are in consequence termed *Copépoda*—i.e. oar-footed. Passing upwards, the powerful prehensile organs are formed by the modification of more limbs. But now we are met by a difficult problem. What are the two circular objects,

and what is their office? These again are modified limbs, the alteration being so complete that it is not easy to trace the component parts. Their office is to aid the claspers in retaining hold of the animal on which the argulus is a parasite. They are in fact suckers, much as the fins of certain fishes are modified into sucking discs, whereby the fish is able to adhere to any smooth surface without the use of muscular exertion.

Lastly we come to the beak through which the argulus sucks the blood of its prey. Strange as it may seem, the beak is also composed of modified limbs. I shall again refer to this subject in our next chapter, and therefore shall not pursue it farther here.

The whole of these structures are so interesting that I strongly recommend the stickleback-keeper, not only to capture every specimen that can be found, and so to rid the fish of an intolerable nuisance, but to preserve them in spirits of wine, so as to have them always ready for microscopical examination. If possible, a few specimens should be mounted for the microscope in Canada balsam, as the structures are thereby rendered translucent.

I mentioned that when the argulus attacks a fish it suddenly disappears. The reason is this. The favourite dwelling-place of the argulus is under the gill-covers, where it can easily penetrate the delicate membranes of the gills with its beak, and is at the same time defended from external dangers.

The argulus does not confine itself to the stickleback, but has been found upon the carp, roach, perch, trout, and even on the tadpole. It seems very hard upon the perch, for, beside the argulus, which it shares with other

fishes, it has an allied species peculiar to itself. The stickleback, however, is the chief favourite of the argulus, and it is scarcely possible to take a stickleback without finding at least one argulus attached to it. One case is known where no less than thirty specimens of this terrible foe were taken from a single stickleback.

CHAPTER XXV

WADING, OR 'PADDLING'

I HOPE that you are not afraid of the water, for I am now going to take you into it. Not into the deep water, nor indeed into any brook that is slow, and therefore sure to have a muddy bed. But if you are fortunate enough to have access to a swiftly flowing stream, with a bed of rock, stones, or gravel, you will probably find it to contain the creatures which will be presently described.

Provide yourself with a covered basket in which you can put your captures, and fasten it to your waist, so as to leave both hands at liberty. Tempting though it may be on a hot summer day, do not venture into the water with bare feet. You never know what may lie in the bed of the stream. There may be a little branch of blackthorn, with a thorn projecting upwards, ready to pierce the sole of the foot. Or a piece of broken bottle may have been thrown into the brook by some thoughtless person, or you may step upon the edge of a freshwater mussel, the shells of which will cut as if they were knife-blades. I speak by experience, having suffered from all these hindrances to wading in a brook. So always put on a pair of old shoes with tolerably stout soles, and be sure to punch some holes in the upper

leather, so as to allow the water to pass through freely. Of course you will wear nothing that can be spoiled by water, for, take what care you will, you will be much wetter than you intended before you finish your wading.

Choose some spot where the bank rather overhangs the stream, tuck up your sleeves as high as possible, and enter the stream. Now grope carefully under the bank, beginning as low as you can reach, and working your way upwards, taking care not to leave an inch of the bank unexplored. Especially try to find a hole in a spot where it is quite invisible from above. This will be the burrow of a water-vole, such as has already been described. Trace it into the bank as far as you can. Probably there may be nothing in it. Do not be afraid of being bitten by the maker of the burrow. The water-vole is a harmless being, and if he should happen to be in his burrow, he will make his escape by another opening.

Perhaps you may feel something sharp in the burrow, as if your fingers had come upon thorns. These points will belong to the head of a crayfish (*Astacus fluviatilis*), and you have now to capture the creature. Feel about the hole, and you will become aware of some long flexible objects about as thick as twine, but very hard. These are the antennæ or feelers of the crayfish. Grasp them smartly with your finger and thumb, jerk out the crayfish, and drop it into your basket before the creature has had time to recover from its astonishment. You must be very quick about it, for the crayfish has a pair of strong pincers, and can inflict a smart bite. Some specimens, when once they succeed in grasping their adversary's finger, hold on like bull-dogs, and it is no

easy matter to induce them to loosen their hold. However, they can be outwitted in the following manner. Detach the basket and immerse it in the water, at the same time letting the crayfish into the basket. Feeling the touch of the water, the crayfish thinks that it has been restored to its home, and immediately relaxes its grasp.

When I first began to catch crayfish in this manner, I sustained several shrewd bites; but after a while I could catch them by the dozen, and never receive a bite.

There are other modes of catching the crayfish, but I have chosen this method for several reasons, the chief of which is that no one can fully understand a fellow-creature without following it into its haunts, and, in fact, partaking of its nature. Those of my readers who are obliged to keep themselves dry-footed can catch the crayfish by the ordinary hoop-net baited with a piece of meat. But they can never take the same personal interest in the creature as they would have done if they had followed it into its native haunts, and captured it with unaided fingers.

When I was a small boy, crayfish-catching was a very simple business. In those days, boys' caps were caps indeed. None of your ounce-weight cricketing caps, which can be crumpled up in one hand, but cloth caps with plenty of room in the crown. The cap was the only article of apparel with which we troubled ourselves.

We used to conceal our clothes in a safe hiding-place, swim half a mile or so down the river, and then work our way back, examining every foot of the banks,

When we captured a crayfish, we put it into the ever-ready cap, and replaced the cap upon our head. Of course the crayfish scrambled about within the cap, and occasionally gave a sharp pull at a lock of hair, but we never troubled ourselves about trifles, and were perfectly happy with a dozen or so of crayfish on our heads.

There is no difficulty in conveying the crayfish home, the chief difficulty being in keeping them in health after they are transferred to the aquarium. A crayfish consumes a wonderful amount of oxygen, and if the captive be placed in a deep vessel it will probably die in an hour or so. It can live out of the water well enough, provided that it be occasionally dipped or sprinkled sufficiently to keep its gills moist, but even a pailful of water will not serve for the respiration of a single crayfish. This lesson I learnt at a very early age, when I brought my captives home, put them in a pail nearly full of water, and found them all dead on the following morning.

By far the best aquarium for crayfish is a wide, shallow pan, with only an inch or so of water in it. Of course, if running water can be secured, any kind of vessel will suffice; but such conditions are so rare that they can scarcely be taken into consideration.

Having secured a few specimens of the crayfish examine one of them in detail; if possible using as a guide Huxley's work, to which I have already referred. Without going into the abstruse details of pure science, we can easily trace the modifications of the limbs. Some of them are used for walking, others for swimming, others for prehension, while others again are so

gradually modified into jaws that it is scarcely possible to decide where the legs end and the jaws begin.

As two extreme cases, we will take the tail-fins and the claws. Unlike as they may appear to be, they are composed of the same elements, and each joint can be recognized. The widened and flattened "tail-fan" is really a pair of flattened legs, as can be seen in the swimming legs of the Fiddler crabs.

The structure of the claws is equally easy of explanation. No new structure is created. The last joint but one is greatly enlarged, so as to contain a powerful flexor muscle, while the last joint is comparatively undeveloped, and is reduced to a pinching instrument, which is worked by the huge muscle contained in the previous joints. These pincers are specially useful to the newly hatched crayfish, which clings by them to the swimming-legs of its mother, and, without any voluntary exertion, is swept backwards and forwards through the water, so as to obtain a sufficient supply of oxygen.

Some years ago I succeeded in hatching a number of crayfish eggs. The eggs, like those of the lobster and shrimp, are attached by membranous threads to the swimmerets. Many of them were hatched, but I regret to say that I never could see them afterwards, and very much fear that they must have been eaten by their parent.

Like all crustacea, the crayfish casts its shell periodically, and if you can keep your crayfish long enough, you will have the opportunity of seeing it change its garment.

As the crayfish, like other crustacea, has its bones

outside its muscles it cannot grow in the way which is common to the vertebrated animals, which have their muscles outside their bones. As long as the creature has to grow, a second skin forms underneath the covering which is in actual use. When all is ready, the original skin splits at the junction of the thorax and abdomen, and the crayfish emerges, leaving behind it the original skin in so perfect a state that it might easily be taken for a living animal.

At first it is quite soft and helpless, but it rapidly accretes lime from the surrounding water, and, by the wondrous chemistry of Nature, is speedily enveloped in the shelly armour with which we are so familiar.

Every one knows that the crayfish, as well as the lobster, is of a blue-black hue when alive, but changes to scarlet when boiled. It is remarkable that alcohol has the same effect as boiling water upon the colouring matter of the shell, changing it to bright scarlet, so that when a dissection of a crayfish is preserved in spirits the shell looks exactly as if it had been boiled.

As we are touching upon the shell, we will cast a glance at its structure. The resemblance of the shell to the plate-armour of the Middle Ages is almost too obvious to need mention, man having evidently copied Nature. A suit of armour was double. First there came a suit of buff leather, fitting closely to the body, and over it were fastened the plates and bands of steel, each playing on rivets so as to allow free movement of the limbs. This armour was, however, nothing but a very clumsy imitation of the natural defence of the crayfish. When a crayfish casts its coat, it is arrayed simply in a tough skin, which is analogous to the buff

coat. The celebrated 'soft-shelled' crabs of the West Indies are simply land-crabs which have recently cast their shells, and have not had time to secrete the hardening matter.

If the shelly material were to be deposited equally over the skin, the animal would be absolutely rigid, and would not be able to bend either its body or limbs. But the deposition stops short at each joint, and thus the capability of motion is preserved. If you can keep a crayfish until it sheds its shell, it is interesting to take the shell while it is still fresh and bend it backwards and forwards, so as to see the beautiful mechanism of the joints.

Sometimes you will find a crayfish with one large and one small claw. This discrepancy can be easily accounted for. When any soft-skinned animal is wounded, Nature sets to work at repairing the damage, and the congealed blood acts as a plaster. But this is impossible with the hard-shelled crayfish, and accordingly there is another mode of repairing damages. Should a claw be wounded, the animal has the power of shaking off the entire limb at the second joint from the body, a sort of skin immediately forming over the severed joint, and preventing loss of blood. Crabs and lobsters have the same faculty, and if one of these animals be plunged into boiling water it always flings off its claws. Any sudden shock will have the same effect—a fact of which our naval officers of old times were not slow to avail themselves. When they found themselves near shore, where lobster and crab-pots were set, they demanded a tribute of crabs and lobsters, threatening, in case of refusal, to fire the ship's guns. The shock of the explosion would make all

the lobsters and crabs of the neighbourhood cast off their claws, and so render them almost valueless for the market. Spiders, who can claim a sort of relationship with the crustacea, have a similar power.

Now for the respiration of the crayfish. As I have already mentioned, the crustacea breathe by means of gills, which are placed under the 'carapace,' as the large plate is called which defends the vital organs, and very much resembles, both in appearance and office, the cuirass of armour. Remove the carapace, and you will see under it a number of white, feathery objects, which in the lobsters and crabs are popularly called 'ladies' fingers.' These are the gills, and, as I have already mentioned, they consume a very large amount of oxygen.

Next we may look at the eyes, which are compound, like those of insects, except that the lenses are square instead of hexagonal. The crayfish makes good use of these eyes, as may be seen by those who keep the creature in captivity. Yet in the wonderful caves of Kentucky there are crayfish which are without eyes, those organs being useless to dwellers in darkness.

Before taking leave of the crayfish, I may mention that its popular name has nothing to do with a 'fish,' the word being simply a corruption of the French word *écrevisse*, and in olden times we find it given as 'crevis,' or 'crevice,' the orthography of our ancestors being of the loosest description.

The crayfish is rather a capricious creature with regard to the localities which it affects. As is the case with snails, which are not to be found in localities which do not afford sufficient lime for the formation of

the shell, the crayfish cannot live in streams which do not supply lime for the armour which encircles the body. The need for lime is so great that, just as deer nibble the horns which they have shed, in order to obtain material for new horns, so the crayfish makes use of the shed armour, and by degrees contrives to absorb it into its system.

CHAPTER XXVI

THE RIVER LAMPREY, OR LAMPERN

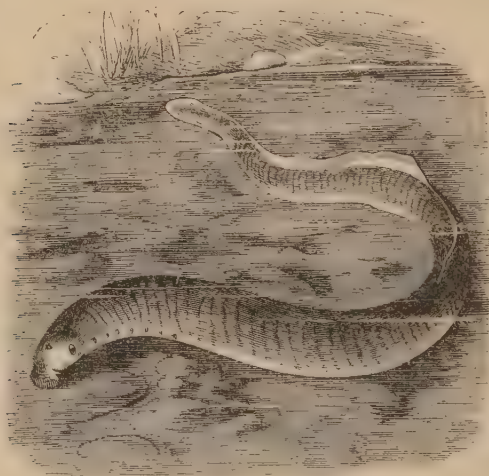
Now we will pass to some other inhabitants of the waters, which can only be watched by 'paddling.' One of the most interesting of them is the River Lamprey, or 'Lampern,' as it is more properly called (*Petromyzon fluviatilis*).

The Lampern.—From early childhood I have taken a great interest in this remarkable little fish, partly perhaps from a spirit of contradiction, because it was an object of dislike, not to say fear, to most people. In length it is about fourteen or fifteen inches, and in thickness about equal to a rather large lead pencil. Its mouth is notable for the resemblance which it bears to that of the leech, and the use which is made of it. The generic name, *Petromyzon*, literally stone-sucker, is singularly appropriate, the fish passing most of its time adhering to stones. This it does for two reasons. In the first place, it is not a strong swimmer, and therefore requires to hold to some fixed object in order to prevent itself from being swept down the stream. In the next place, it wants to excavate holes in the river bed for the purpose of depositing its spawn.

Watching the lampern under both these conditions is singularly interesting. In the first place, it is really wonderful how the lampern escapes observation, even in

streams where it swarms. Repeatedly I have pointed out a bunch of thirty or forty lamperns, and been disbelieved, the spectators taking them for river weeds, which they certainly do resemble, their flexible bodies waving in the stream just like the long-leaved weeds.

I never saw a lampern swim for any distance without



THE RIVER LAMPREY.

halting. It undulates its way up-stream for a few yards, and then affixes itself to a stone by means of its sucker-like mouth, and, after it has rested for a while, it takes a fresh departure and works its way up the stream for a few more yards. Sometimes, when the stream is swift, as is usually the case in Derbyshire, and the stones which form the river bed are large and smooth, forty or fifty lamperns may be seen clinging

to one stone, using it as a resting-place on their way up-stream.

But when they want to make a spawning-ground, they set to work in a very systematic manner. Attaching themselves to a stone, they make a retrograde motion, their lithe bodies whirling round and round until they resemble a living screw. The stone is thus detached from its place, and is carried a few yards down the stream, where it is dropped. This process is repeated until a hole has been scooped up sufficient to meet the needs of the lampern.

I regret to say that, with the characteristic wastefulness of our nation, we do not make nearly as much use of the lampern as we ought to do. In the first place, it is an extremely valuable bait for cod, turbot, and other fastidious fishes, because it can be kept alive for several weeks. In the next place, it is very good to eat, though its edible properties are too often ignored. In several places, however, Worcester among the number, its value is recognized, and it is potted and considered as a dainty.

This, I may mention, is not the fish which is said to have given Henry I. his death, that being the much larger lamprey of the sea.

The lampern is easily caught with the bare hands, as it seldom seems to take alarm when approached, and can be pulled from its hold without difficulty. When thus captured, the creatures have a rather alarming habit of twisting their long slender bodies round the wrist, and fastening upon the hand just as if they could bite. They retain their hold very firmly, but cannot even break the skin.

One interesting point in the structure of the lampern is the mode of respiration. Instead of having the usual gills, it has on either side of the neck seven little sacs, each communicating with the water by means of a small hole, thus giving to the fish the appearance of having eight eyes. Indeed, in some places, the boys call it by the popular name of Nine-Eyes.

Bull-head.—Now for a few more fish which can be reached by wading. One of them is the odd-looking little fish which goes by the popular name of Bull-head (*Cottus góbio*). The name is very appropriate on account of the large comparative size of the head. Sometimes it is called the Miller's Thumb, the thumb of the miller being supposed to be widened and flattened by perpetually rubbing samples of meal.

The chase of a bull-head is an amusing and interesting pastime. It loves shallows where it can find plenty of stones under which to hide. As you work your way up the brook, lift carefully every large stone that you meet. Suddenly you will see a little brown fish dart from under the stone, and with great rapidity make its way up-stream to another stone, under which it conceals itself so well that it is not easily seen. A little practice, however, will soon enable the eye to detect it by means of the tail, which the fish is obliged to keep in motion in order to maintain its position against the stream. By continually driving the bull-head out of its refuge it becomes at last so tired that it can be captured by hand.

Frank Buckland mentions that at Winchester, where he was at school, one of the favourite sports among the

boys was to spear 'Tom-Culls,' as they were termed, with a fork tied to the end of a stick. Then, together with minnows and loaches, they were pickled, and formed an important part of the extraordinary luxuries in which schoolboys delight. He also mentions that he has seen two instances where kingfishers have been killed by trying to swallow bull-heads, the fish having instinctively thrust out their spines while being swallowed, and thus choked the bird. I have seen one such case myself.

Loach.—Resembling the bull-head in habits is the common Loach (*Cobitis barbatula*), easily recognizable by its slender, slippery body and its fleshy barbules that hang from the mouth. Pickled loach is in great favour among boys, who capture the fish with a fork, just as has been related of the bull-head. For a most vivid and accurate account of loach-spearing, I must refer my readers to the beginning of *Lorna Doone*, where John Ridd first meets the heroine of the tale. Though the loach can be tired out like the bull-head, it is much more difficult to catch on account of its very slimy skin.

Trout.—Hardest of all to catch is the well-known Trout (*Salmo fario*).

When I was a boy my schoolfellows and myself used to catch plenty of trout in the river Dove and its tributary streams. We never troubled ourselves about rods and line, but trusted entirely to our fingers. I know that catching trout in this way—'tickling' them, as it is called—is by most persons considered as sheer poaching, and therefore as little less than a crime. I cannot agree with this theory. Of course, if the water be private property, catching the fish will be poaching, no matter what may be the means. But, granting the

water to be free, I think that to pit the unaided hands against so wary, active, and powerful a fish as a trout is as legitimate a sport as employing the rod and line. Just try to tickle a trout, and you will find that the fish will put every faculty to the strain before it is captured.

There is one remarkable point in the life-history of the trout—namely, that like the pike, a fish of a certain size always takes possession of the same hole; so that if you take out of a hole a trout of a pound weight on Monday, you will find on Tuesday that the same hole will be occupied by another trout of much the same dimensions.

This is the way to tickle trout—and I assume that you will not be unsportsmanlike enough to catch a small fish. Knowing the holes in the brook bank which are sure to be occupied by trout, and also knowing that a fish always lies with its head up-stream, you very carefully introduce one hand under the trout's home. Let the tips of your fingers just touch the under surface of the fish, and generally it will give a startled flounce or two. Never mind the flounce, but keep the tips of your fingers just resting against the body of the fish. Then begin to rub the fingers gently against the fish, and presently you will feel it pressing itself upon them. Gradually slip your hand forwards until the first and second fingers and the thumb are lightly encircling the head. Now introduce the other hand, and get the fingers round the small of the tail. Now close both hands slowly but firmly.

Here lies the chief difficulty. If you do not close them tightly enough the fish will wriggle itself loose and be off, while, if you close them too suddenly the active fish will take fright and twist itself from your grasp. If you hold it properly, it will kick violently for some time, and

then relax its efforts. The moment that it does so, draw it quickly from the water, and throw it ashore, taking care to fling it sufficiently far from the water to prevent it from finding its way back.

We generally used to work in pairs, one hunting for trout, and the other remaining on the bank to make sure of the fish. At first you will lose many a fish, and will imbibe a very hearty respect for its wiles. At last, however, when you have become an expert, you will feel almost sure of your fish when you once touch it.

CHAPTER XXVII

THE UNIO, OR FRESH-WATER MUSSEL

Do not quit the water, for there is plenty of work yet to be done in it. I mentioned casually that within the mud which will be found in some parts of the bed of every brook there lurked certain treacherous shells, which would cut an unprotected foot as if they were knife-blades. These are the shells of the Fresh-water Mussels (*Unio*), which simply swarm in most of our streams. There are several species of *Unio*. As mentioned, these mussels have a very troublesome habit of burying themselves almost entirely in the mud, leaving only the edges of the shells above the surface, so that it is very difficult to keep a look-out for them, especially as, no matter what care you take, it is almost impossible to avoid stirring up some of the mud.

One of the reasons why you should always wade up, and not down the stream is, that when you stir up mud, all you have to do is to wait for a short time, when the mud will be washed away, and the water become clear again. After a time, you will mostly be able to see a unio, and at all events can guess with some accuracy the spots where it is likely to be found. It has an unpleasant habit of keeping the shells a little open, so that there are two cutting edges to be trodden upon instead of one.

If you take one of these shells home, and put it into a

vessel with a few inches of sand, you will see how it attains its favourite position. At first it lies quiet, but in a little time becomes uneasy at finding itself on its side. Then it opens the shells, puts out its foot, and wriggles about apparently without any special object. By degrees it works a groove in the sand, and then wriggles its way into the groove, keeping the hinge downwards. It now proceeds with much more rapidity, and in a short time will sink itself almost completely in the sand.

When the animal has been removed from the shell, the latter is of a beautiful blue upon the internal surface. The outer surface looks a simple olive-brown. But when the dark epidermis which covers it is removed and the shell polished, it is, if possible, even more beautiful than on the inside, glowing with various shades of green, blue, pearly white, etc., all having a lovely iridescent play of colour. In my boyhood the polishing and arranging of these shells was a favourite pastime, and very pretty objects can be made of them.

This species derives its name from the fact that in former days the shells were much used by painters as small palettes, just as the shells of the common marine mussel are still used for holding gold and silver water colours. Another species is the River-pearl Mussel (*Unio margaritiferus*), so called on account of its faculty of producing pearls. At the present time, the river pearls are not considered valuable enough to repay the trouble of collecting. Only the oldest and most misshapen mussels contain pearls, and even of these scarcely one per cent. has a pearl in it; while out of a hundred pearls scarcely one is clear enough to find a sale

Now and then a pearl as large as a pea may be found, and will fetch some three or four pounds. But this is very rare. When the Romans occupied Britain, however, the pearl fishery was highly valued, and an exceptionally large river pearl, given by Sir Richard Wynn to Catherine of Braganza, and by her to Charles II., has found a place in one of the English crowns. Another, called the Ythan pearl, from the river in which it was taken, is said to be in the Scottish crown now in Edinburgh Castle. The rivers of Scotland and Wales seem to have been richer in pearls than those of England.

Incidental reference to the value of the river pearl is made by Shakespeare, *Hamlet*, Act V. Sc. 2 :

The King shall drink to Hamlet's better health,
And in the cup an union shall he throw,
Richer than that which four successive kings
In Denmark's crown have worn.

The 'union' which the King pretended to throw into the cup, but was in reality a quick poison, signified the river pearl taken from the unio shell.

River pearls are still plentiful in Ireland, and are sold to tourists. They are mostly tinged with pink, but jewellers do not care about them, as they are not easy to cut. The Scotch pearls also are apt to be more or less pink, but are more valuable than the Irish—a necklace made of Scotch pearls having been valued at two hundred and fifty pounds, one of the largest pearls being said to be worth more than eighty pounds.

About a century ago, the river-pearl fishery was really a profitable business, some of the fishers selling a hundred pounds' worth of pearls in a single year—*i.e.*

about twice the amount in those days, considering the altered value of money.

Unfortunately, the fishers never looked farther than present gain, and in about twenty years cleared the rivers of mussels, thus killing the goose that laid the golden eggs. So completely were the rivers ransacked that Pennant, who made a survey of Scotland in 1769, says that within the three years from 1761 to 1764, ten thousand pounds' worth of river-pearls were sent into London from the river Tay alone.

Dishonesty seems to have been as rife among the labourers employed in the pearl fishery as is still the case among the men who are employed in the diamond mines. They knew by experience which shells were most likely to contain pearls, and had a knack of opening them under water, extracting their precious contents and hiding them.

Great numbers of mussels were also stolen by a very simple device. I have mentioned that the mussel always lies with its hinge buried deeply in the mud, and the edges of the partially opened shells projecting upwards. The poachers walk along the banks of the stream armed simply with a long slender stick, such as would pass muster for a rude fishing-rod. When they see a likely looking mussel, they insert the end of the rod between the shells. Instinctively the mussel closes its shells tightly on the intruding stick, and is hauled ashore before it has time to loosen its hold. A moment suffices to force it open, to extract the pearl if one be present, and then the shell is thrown back into the water.

The dishonest labourers who have already been mentioned would, if they found themselves very closely

watched, insert a toe into the shell, and, regardless of the pain, carry it about until they could find an opportunity of twisting it open.

From time immemorial the ever ingenious Chinese have produced artificial pearls from an allied species by inserting foreign substances between the shell and the mantle, so as to set up a diseased action, and force the creature to deposit nacre on them. One favourite branch of this art is to stamp little josses (images) out of bell-metal and insert them under the mantle. In process of time they become so thickly covered with nacre that they look as if they had been natural growth.

ANOTHER species of mussel has of late years domiciled itself in our streams, but has no terrors for bare feet, as it does not bury itself in the mud or sand, but hangs on the roots of trees, or even to branches that droop into the water, suspending itself by a 'byssus' like that of the edible mussel. This is the chambered mussel (*Dreisséna polymorpha*), a very remarkable creature, with a history of its own. It is extremely variable both in shape and size, so that it well deserves its specific name of polymorpha, *i.e.* many-formed. On an average it is about half as large as the edible mussel, and is much thicker in proportion to its length. Its colour is also variable, but may be described as dark olive-brown, with substratum of indigo.

Its popular name of chambered mussel is given to it on account of the structure of the shell. On the interior of the valve is a ridge of nacreous matter, which divides off a portion of the shell, so as to form a sort of chamber.

Another remarkable point about the creature is its

exceeding hardness of constitution, in which it is fully the rival of our friend the stickleback. As a general rule, salt water is fatal to fresh-water molluscs, and *vice versa*. But the chambered mussel is quite indifferent to the saltness or freshness of the water, and, indeed, owes its presence in this country to this quality. Normally, it is a species belonging to the Continent, but in 1824 some specimens were detected by Mr. Sowerby in one of the London Docks. Thence it began to spread itself throughout the fresh waters of England, slowly at first, but afterwards with wonderful rapidity.

Not the least remarkable point about it is the suddenness with which it appears in waters where it has never before been seen. I had from earliest childhood been in the habit of wading in the Cherwell and Isis, and had explored every bank that was within reach of the hand. Yet it was not until 1844 that I ever saw it. Along the banks of these rivers and their tributaries are many weeping willows, the tips of whose branches often droop into the water. One day, while wading as usual along the banks, I found one of these drooping branches in the way, and pushed it aside, lifting it out of the water at the same time. To my utter astonishment I found it laden with mussels, clinging to the branches by a byssus like that of the marine mussel.

This was surprising enough, but I presently found many more of the same shell, some clinging to submerged branches, and others adhering to the willow roots which had grown into the water. Almost simultaneously, the shell appeared in 'Mercury,' as the circular fountain pond in Christchurch College, Oxford, is still called, though the statue of Mercury, which once

decorated its centre, has not been seen for at least half a century. The fountain is fed from the Isis, and in consequence the shells found their way through the pipes. Since that time they have penetrated into private houses by the same means. The rapidity with which it increases is simply amazing. When I first found it at Oxford, I am absolutely certain that not one was to be seen in the preceding summer. Yet some of the groups which I found clinging to the willow roots would have filled an ordinary hat.

This is perhaps about the last shell in which we should expect to find pearls. Yet I have seen a specimen in which was a pearl. It was a very irregular and badly coloured pearl, so that it was of no value in a pecuniary sense. But to the naturalist it possessed considerable value, as exhibiting the mode in which pearls are formed.

Now we will leave the bivalves and turn to some of the creatures which go by the popular name of water-snails. These molluscs belong to the vast army of gasteropoda, of which our common garden snail and slug are rather too familiar examples.

These creatures dislike swiftly running water, so that it is useless to look for them in the more rapid portions of a brook, though the same stream will furnish them plentifully in those places where the water happens to be comparatively still. It often happens that even in a rapid stream like the river Dove there are little bays, causing what is called a 'backwater.' In these bays the water is so unaffected by the stream, that if a cork be thrown into one of them, it will go circling slowly for an hour or so before it is finally drifted into the main stream. In

these tranquil spots the water-snails are sure to be found in almost any number, and they are well worth the trouble of watching.

Being gasteropoda, they are necessarily slow walkers—if indeed they can be said to walk at all. It would therefore be difficult for them to change their locality, if they had to depend upon the usual mode of locomotion. The all-useful ‘foot,’ therefore, instead of being used as a foot, is convertible into a boat, thus enabling the animal to float instead of walking. It is first spread to its fullest extent, and is then hollowed in the centre, so as to give it a cup-like form. The animal then turns over, so as to bring the hollowed foot uppermost on the surface of the water. The foot then plays the part of a boat, and, as the rest of the creature is submerged, the flotation power, slight as it may be, is amply sufficient for the purpose, the passenger being under and not in the boat.

These primitive vessels then commit themselves to the stream, and on a favourable day may be seen floating down the current by hundreds. No steering apparatus is needed, as floating objects, especially if they be rather deep in the water, will keep in the centre of the current, and practically steer themselves. Wild-fowl shooters who pursue their craft upon tidal rivers are aware of this fact and utilize it. They launch themselves upon the river in a boat painted white, so as to be invisible at a distance, keep their guns in readiness, and allow themselves to be carried along by the stream, the boat turning the corners as accurately as if it were steered by hand.

Take notice of the peculiar horny shield with which the mollusc protects itself when it draws into its shell.

In some of the exotic molluscs the operculum is thickly covered with shelly matter on its interior surface, and assumes such beautiful tints that it is in great request in the manufacture of sleeve-links, the convex and coloured surface being turned outwards.

Another typical water-snail is the planorbis, a mollusc whose shell is coiled on itself, much as ropes are coiled and laid on a yacht's deck. In fact, these little fresh-water shells very much resemble in external form the long extinct ammonites. When very young, the planorbis is a favourite victim of the caddis worm, which will sometimes annex seven or eight planorbis shells, together with their inhabitants, and fasten them to its habitation.

Some of the water-snails deposit on the glass sides of the aquarium certain oblong masses of seeming jelly. After a little time, eggs are seen to be developed in the jelly, and are singularly interesting objects when viewed through a magnifying glass. By degrees extremely tiny shells are developed within the egg, and keep incessantly whirling round like the servants of Eblis in 'Vathek.' When a microscope is brought to bear upon them, they are seen to be covered with very minute bristles, or 'cilia,' by whose automatic movements the ceaseless whirl is kept up. When they are strong enough to emerge from the shell, and be launched into the world, the cilia are no more needed, the foot becoming the normal means of locomotion.

CHAPTER XXVIII

WATER-SPIDERS

HERE is indeed a strange title.

We are all more or less accustomed to spiders in the house, whence they are ejected as soon as seen, as most of us object to their presence there. Garden-spiders, with their beautiful wheel-like webs, are equally familiar, and not in the least objectionable, especially in the early morning, when their symmetrical webs are strung with dew-drops, every drop glittering in the sunbeams as if it were a veritable diamond. The 'gossamer' spiders, which are wafted into the air as the summer sun pours its heat on the earth, are equally familiar, if only by name.

All these spiders are at least in the air, on which they are dependent for existence, quite as much as we are. But spiders and water seem to be absolutely opposed to each other, and at first sight it would appear as if the expression 'water-butterflies' would be scarcely less absurd. Yet there are several spiders who obtain their food in or on the water, and there is one species which, although it breathes atmospheric air like ourselves, is not only hatched below the surface of the water, but passes the greater part of its adult life under water.

The Water-Spider (*Argyroneta aquática*). — This

very remarkable being has nothing about it to attract attention as long as it is out of the water, and only seems to be a plain, brown spider with rather long and very hairy legs, and to a casual observer is totally un-



ARGYRONETRA AQUATICA.

interesting. But as soon as it enters the water it is quite transformed, and is hardly more recognizable as the same being. The best way of watching this spider is by taking it home and keeping it in a glass vessel.

There is not the least difficulty in capturing the

creature, as it is extremely common, and can be taken in any numbers by those who know its way. I was once delivering a lecture on spiders to the boys of a large school, and happened to mention this fact, at the same time saying that as there were many ponds near the school, the boys could easily procure specimens for themselves. After the lecture was over, some of the boys came forward and said that, unfortunately, the water-spider did not exist in that district. Being rather surprised at such a statement, I suggested a visit to the ponds. The boys had no water-nets, and so I asked for a butterfly-net. Presently we came to a small pond, into which I inserted the net, and at the first dip brought out six fine specimens of the water-spider.

Almost any vessel will make a good home for the water-spider, provided that it be deep and transparent. There is no need to have a wide absorbent surface, as is the case with the stickleback, because the creature does not depend upon the water for the oxygen which is needed for respiration. I have kept many of them, and have mostly employed the cylindrical glass jars such as are used by confectioners for the more tempting display of sweetmeats. As the spider requires plants of some sort to which it can attach its wonderful habitation, an anacharis or vallisneria may as well be planted in the vessel.

I do not recommend more than one inmate of a small vessel, especially if they should be of opposite sexes. At the best, spiders are quarrelsome creatures, and, contrary to conventional ideas, while males *may* quarrel with males, and females are likely to quarrel with females, a female spider is almost certain to quarrel

with a male. The quarrel is none of his seeking. He knows better than to quarrel with the opposite sex. A male spider is a very inferior being compared to the female. He is much smaller and weaker, and, except in very rare instances, is never seen occupying the same domicile as his wife.

As a rule, love-making is exceptionally dangerous to the male sex among the spider race. 'Love me, or I die,' is a favourite metaphor among human beings, but among spiders generally it is a stern and prosaic fact. For the male makes his advances to the lady of his love at the peril of his life. This may often be seen in the common garden spider. The male advances very cautiously to the web occupied by the lady, and gives a little pull at one of the threads. Out runs the female, and, if she should not happen to approve of his appearance, she charges at him, and, if she can catch him, will kill him and suck his blood. Of this he is well aware, and therefore does not venture to approach until he has secured his retreat. So at the first sign of her disapproval he lets himself drop to the ground, and makes his way towards his own web.

In this country the disparity of size, though conspicuous, is not so much marked but that the two can be recognized as belonging to the same species. But in tropical America there is a species of spider (*Nephila plumosa*), the female of which weighs thirteen hundred times as much as the male, and is proportionately formidable to him.

The female water-spider, however, is not so quarrelsome as is the case with many species, and if the aquarium be a tolerably large one, the spiders will

mostly keep themselves apart, and will not meddle with each other. If, however, the vessels be small, there should never be more than one inhabitant to each.

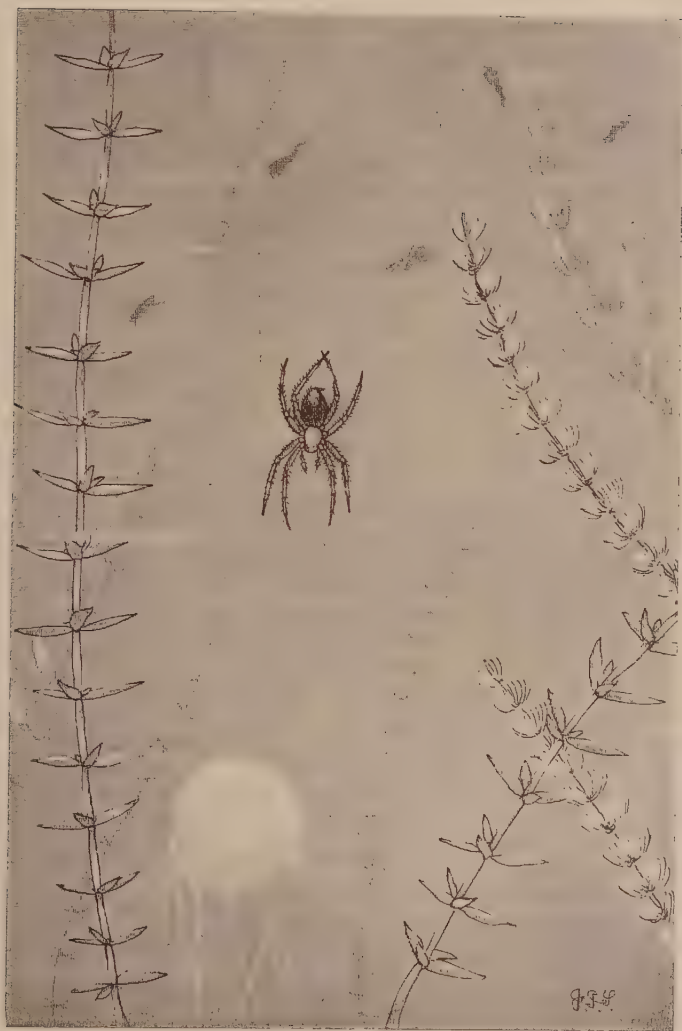
Before the spiders have been long in their new home they will set to work at web-making. Now, as the web is under water, while the spider breathes atmospheric air, it is evident that there must be something peculiar in the structure both of web and spider. In the first place, as the spider must be deprived of access to the external air during the long task of forming the very elaborate web, it must therefore possess some mode of respiration. Then, as the young spiders are hatched under water, and do not enter the open air until they have attained some size and strength, it is equally evident that the web must in some way be supplied with air. We will see how this double problem is solved.

The respiration of the spiders is quite unlike that of insects, which also breathe atmospheric air. As we have already seen, the bodies and limbs of the latter are permeated with air-tubes opening into a set of apertures called spiracles. But the spiders breathe by a kind of semi-lung, having its opening on the under surface of the body, close to the base of the last pair of legs. I have already mentioned that the body and limbs of the water-spider are extremely hairy. When it dives, in order to make its subaquatic home, a quantity of air is carried down with it, entangled among its hairy coating. Spiders do not need much air, and even this comparatively small supply is sufficient to sustain life for a considerable time. When it is exhausted, the spider has only to ascend to the surface, and then to renew the supply—a task which only occupies a few seconds.

At first the creature sets to work much as the garden-spider does—*i.e.* by fixing a number of strong guy-ropes, or cables, for the support of the future web. Although you may see the spider drawing out and fastening these ropes, it is not so easy to see the cords themselves, because their refractive power is nearly the same as that of the water in which they are immersed. A ray of sunshine, however, will betray them, just as we can easily see a spider-thread glittering with iridescent hues in the sunshine, while we lose sight of it as soon as the light changes. This task occupies some time, and is evidently the result of much care, the form of the future nest depending much upon the character of the plants to which it is attached.

The spider then sets to work at its future dwelling-place. She—for the female makes a much more perfect nest than is needed by the male, who always lives the life of a bachelor—begins to weave a nest which is always more or less a corn-shaped hollow, with an opening below. It looks quite loose in texture, and anything but air-proof. Yet in some mysterious way it can be filled with air, and will retain that air as perfectly as if it were a glass bottle. The air never seems to escape from the nest except when removed by the spider itself in a manner which will presently be described. Indeed I have, by way of experiment, taken the spider out of the water, and transferred her to another vessel, leaving the nest filled with air. Yet none of the air escaped, and when I restored the spider to her home a few days afterwards, she returned to her cell, and found it unchanged.

Now, let us see how she fills this nest with air. She



The Silver Water-spider and His Home.

goes to the surface of the water, keeping her head downwards, and holding her long, hair-clad hind-legs as high as she can out of the water, the tips very nearly, but not quite, meeting. Then with a quick plunge she dives head downwards, carrying with her a large bubble of air within the curved grasp of her hind-legs. As she passes through the water she is so transformed as to be hardly recognizable. The air which is entangled among the long hairs which cover the body glitter as if they were little spheres of polished silver, while the great air-bubble that is imprisoned by the legs has given to the creature the very appropriate name of *Argyroneta*—i.e. silver-swimmer.

As the buoyant powers of the bubble would be too great to be overcome by the diving capabilities of the spider, she previously draws some cable-threads from her nest to the upper portions of the aquatic plants to which it is attached. Along these guide-ropes she makes her way until she reaches the opening at the bottom of the nest. Placing herself carefully under it, she gives a sharp kick, and shakes off the bubble, which immediately ascends into the nest, occupying the upper part, and displacing a corresponding amount of water. She then ascends afresh, brings another bubble, and does not cease from her task until the nest is quite filled with air.

When empty, the nest is almost invisible, but the filled cell is a most beautiful object, especially when viewed in a bright light. Here we have another example of the fact that human inventions have always had their prototypes in nature. In the subaquatic nest of the water-spider we have the prototype of the diving-bell,

one of the most useful inventions of modern times. In the earlier days of the invention the diving-bell was nothing but a very large tub let down into the water. It was supplied with air by relays of smaller tubs heavily weighted. They were let down from above within reach of the divers, who brought them under the bell, turned them over, and so allowed the air which they contained to pass into the bell, thus exactly copying the plan adopted by the water-spider.

Supposing the cell to be one of the larger kinds, which are destined to be nurseries for the young, the spider deposits a number of eggs upon the upper part of the inside of the nest, thus keeping them as far from the water as possible. She then mounts guard in a very remarkable fashion. She does not remain in the nest, as her body would occupy the space which is needed for air. But she clings to the lower part of the nest, having her back downwards, and embracing the nest with her long legs. A triple purpose is attained by this peculiar attitude.

In the first place the eggs are effectually protected by the body of the mother, no enemy being able to enter the nest as long as she retains her position. In the next place, as she clings to the nest, the opening of the breathing apparatus is brought opposite the aperture, so that she can remain in the same position for a very long time, the air within the nest sufficing for respiration for herself as well as for the eggs.

Again, the structure of her eyes enables her to detect danger in any direction, while she herself remains almost unseen, so completely is she sheltered under the nest. Also, when the young are hatched, it is impossible for

any of them to leave the nest without her permission. It must be remembered that, unlike insects, which with scarcely an exception take no care of their young, and in most cases never even see them, the spiders, and even their relatives the scorpions, are good mothers to their offspring, the young sometimes clambering upon the body of their mother, and clustering upon every portion of her, so that her form is entirely obscured by them. When the water-spider finds that the air within her diving-bell is becoming exhausted, she gives a rapid kick, and dexterously empties the cell of the greater portion of its contents. She then ascends to the surface, brings a bubble of fresh air, and continues the process until the nest is completely replenished.

Should she not use the cell as a nursery, but merely as a dwelling-place, she does not cling to its exterior, but enters it, and remains there with her head downwards. The cell which is made by the male spider is always smaller than that of the female, and is generally rather cylindrical. In fact, it is simply a bachelor's bedroom and sitting-room combined. Perhaps the word 'sitting' is scarcely correct, as he never sits in it, but hangs in it with his head downwards, an attitude which is assumed by many of the spider tribe as well as the bats.

The water-spider is a creature of very uncertain disposition, being in the habit of kicking the air out of its nest without any apparent reason, and either leaving the nest long empty, or deserting it altogether. When kept in captivity, the spider will often do so when disturbed, and before it has become accustomed to human society.

Some years ago I had several of these spiders in glass jars, and was often asked to exhibit them to my friends.

Their capriciousness was such that for a long time there was never a filled nest when any one called. One day, however, some ladies happened to call just as a female spider had completed an exceptionally fine nest.

Knowing that if I had carried the jar into the drawing-room the spider would have emptied the nest before I could reach the room, I went out very quietly, and asked the visitors to come into my study. This they did, but in the meantime the spider had kicked all the air out of the nest, and was reposing herself on the plants at the surface of the water. I waited for some time, hoping that the spider might fill the nest afresh, and so exhibit its beautiful silvery clothing. But the perverse creature declined to stir, and would not even dive, so that my friends saw nothing but a brown spider sitting upon a water-plant.

CHAPTER XXIX

PIRATE-SPIDERS AND RAFT-SPIDERS

THIS is not the only spider which finds its living in or out of the water.

Several species, which are called Pirate-spiders, can run on the surface of the water, and can also crawl down the stems of aquatic plants, and seize upon the various insects which are found there. One species has earned the name of Raft-spider, from the singular manner in which it obtains its food.

Any one who has watched the water must have noticed that many small insects, especially those whose power of flight is small, are to be seen floating upon the surface. This is especially the case in windy weather, their feeble wings not being able to resist the action of the wind.

The Pirate-Spider manages to pick up many of these drowned insects in a very peculiar fashion. It gathers a quantity of dried leaves, bits of stick, and similar materials, and fastens them together, so as to form them into a raft. On this raft it commits itself to the water, and seizes upon any floating insect which may come within its reach. It does not attempt to guide its course, but simply allows the raft to be blown about wherever the wind and stream may take it. Here is another remarkable example of the manner in which the inventions of man have been anticipated in nature.

One species (*Lycosa piratica*) can run on the surface of the water with considerable speed, so as to pick up the floating insects. The reader must remember that the long-legged hydrometras, gerris, etc., which have already been described as running on the water in search of prey, are insects and not spiders, though they are often called by that name by those who are ignorant of entomology.

Not only does the pirate-spider descend below the surface for the sake of obtaining food, but it uses this power as a means of escaping from danger. It can



DOLOMEDES MIRABILIS.

remain below the surface for a wonderfully long time, sustaining life by means of the bubbles of air which cling to its very hairy body, just as has been mentioned of the water-spider.

Like most of the wolf-spiders, to which group it belongs, the female is in the habit of carrying below her body a little globular silken packet containing about a hundred eggs. Nothing can induce her to relinquish her grasp of the egg-packet, and if it be taken away from her by force, she will haunt the spot for hours,

traversing every inch of ground in search of her lost treasure.

We all know how a laying hen can be deceived by a piece of chalk cut into the rude semblance of an egg and placed in the nest. The wolf-spiders are equally without discrimination. If, while the spider is hunting about for her egg-sac, you roll up a little ball of white cotton-wool and lay it in her way, she will mistake it for the egg-sac, pounce on it joyfully, attach it to her body, and be just as well satisfied as if it were the veritable egg-sac of which she had been deprived. The accompanying illustration depicts one of these pirate-spiders (*Dolomédes mirábilis*), together with her egg-sac.

All these wolf-spiders, as their name implies, hunt their prey after the manner of wolves, and do not catch it in a silken snare, as is the custom with most spiders. The celebrated Tarantula spider, whose bite was thought to produce a kind of madness which could only be cured by dancing, is one of the wolf-spiders. I need scarcely say that the tarantula has no such properties, though its bite may perhaps cause annoyance to those who are afflicted with delicate skin and a nervous organization. The 'Tarantella' is so called because the melody was thought to be peculiarly efficacious in expelling 'tarantism,' as the disease was called.

The Scarlet Water-Mite.—Now let us keep our eyes on some still and sheltered portion of the stream near the bank, and we shall probably see a little, round-bodied scarlet creature swimming in the water, and probably clinging to some aquatic plant. This is the very remarkable being called the Scarlet Water-mite

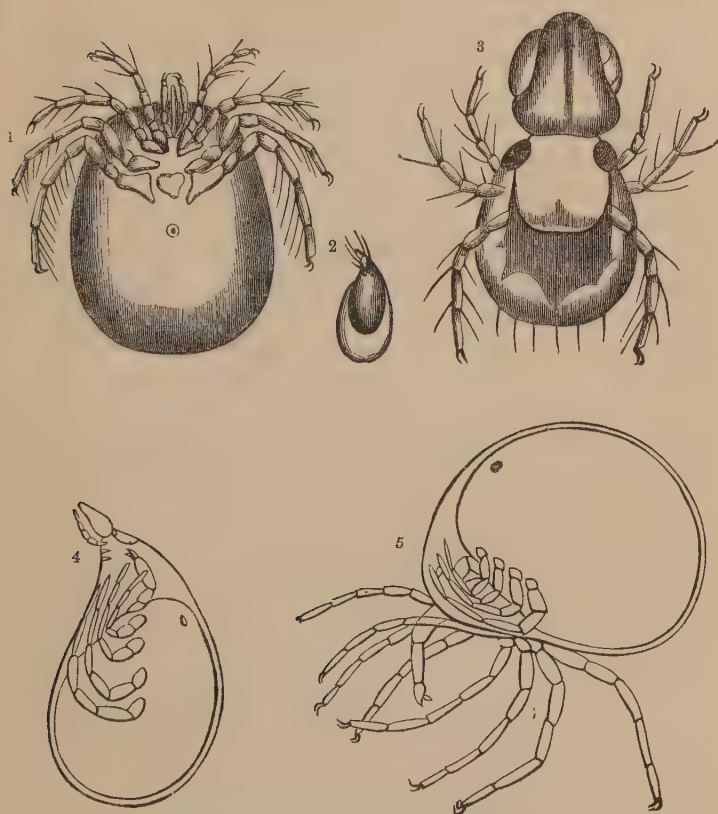
(*Hydrachna*), of which there are several British species. Its scientific name—which signifies water-spider—is a very appropriate one, the true spiders, the scorpions, and the mites being all placed in one group called Arachnida—*i.e.* the spider race. Like many of its kind, it is a parasite, and may be found adhering to the dytiscus water-beetle, the water-scorpion, and other aquatic insects. As it undergoes some very remarkable changes before assuming its perfect form, I have introduced a few figures.

In fig. 1 a much magnified figure is given, showing the under surface of the body, while a view of the upper surface is given in fig. 2. This figure is drawn of the natural size. Both these illustrations show that the creature has eight legs, like the rest of the spider race. Now look at fig. 3. You see that it has only six legs, just as is the case with all insects. In the front of the head there is a powerful organ by which the creature can suck the blood of its prey, and when it has made good its hold it seldom quits its prey until it is ready to assume its perfect, eight-legged form. Strange as it may seem, this odd-looking being is the larval form of the water-mite.

When it is ready to enter upon its second, or pupal stage of existence, it assumes the form which is shown in fig. 3. A magnified view of the pupa is given in fig. 4, showing the way in which the eight legs are packed together, while fig. 5 shows it with its limbs separated, as it appears just before changing into the final and perfect form.

It is a pity that no device has yet been invented by which the beauty of the scarlet water-mite can be

preserved after death. Many years ago I sustained a severe disappointment with it. In my boyish days I



THE METAMORPHOSES OF HYDRACHNA GLOBULUS.

happened to find a nut of gigantic dimensions and deep, rich colour, and was at once fired with the idea of con-

verting it into Queen Mab's chariot, according to Mercutio's description. The nut itself I carved into a delicate filagree pattern, leaving part of it so as to form a canopy over Mab's head. The wheel-spokes were easily made from the legs of the 'harvestman' spider, which is evidently the 'long spinner' of Shakespeare. Nor was there any difficulty in making the 'cover of the wings of grasshoppers,' the 'traces of spider's web,' the whip of cricket's antenna, 'the lash of film,' or in placing the waggoner gnat on the box. The 'collars of the moonshine's watery beams' had to be left to the imagination, but I thought that the 'team of little atomies' would be well represented by eight scarlet water-mites, and a very pretty team they made when newly set in their places. But Mab's scarlet steeds could not retain their former colour, and soon shrivelled up into shapeless, withered, and dull mummies of their former selves. If placed in spirits of wine they soon lose their colour, though they retain their form.

How the creature breathes while under water is somewhat of a mystery. In common with the group to which it belongs, it is furnished with the usual respiratory organs for breathing atmospheric air. But it never seems to come to the surface for the purpose of breathing, and it is thought that, as is the case with several creatures much lower in the scale of life, it may have the power of extracting oxygen from the water by means of its skin.

The Harvest-Mite.—The water-mite has many relatives that live on land, and as you are prosecuting your researches along the banks of the brook you may probably make the personal acquaintance of one of them. This is the almost invisible creature called the harvest-mite,

because it is most rife in harvest time. It is extremely small—so small indeed that to detect a single specimen is no easy task. It lurks among herbage, grasses, and other plants, and as soon as the foot of a human being brushes the leaves, the harvest-mite transfers itself to the intruder, and immediately begins to search for some aperture in the clothing. Owing to its minute dimensions, scarcely any clothing is proof against it, and as soon as it comes upon any unprotected portion, it begins to burrow beneath the skin, where its presence produces a most intolerable irritation. Scratching the afflicted spot only aggravates the mischief, and in some cases will produce sores which last for many weeks.

I have found that in gardens the French bean is a favourite stronghold of the harvest-mite, and, being the unfortunate possessor of a very delicate skin, have suffered severely from its attacks. The grass on chalk downs is almost always infested with these little pests. In his *Natural History of Selborne*, Gilbert White mentions that the professional rabbit-catchers are sometimes driven from their work by the harvest-mites, which even cover the nets so thickly as to give them a reddish hue. In its eagerness for blood, the harvest-mite will even attack dogs and sheep, and has been found upon the wild rabbit. On account of its red colour, it is called in France by the popular name of 'rouget.'

It is really a mystery why the harvest-mite, in common with the mosquito, gnat, and other troublesome insects, should be so bloodthirsty. Blood is not their natural food, and countless generations pass their whole lives without ever tasting blood, or, indeed, without ever coming in contact with any of the creatures which they

persecute so remorselessly when they have a chance. Take, for example, the mosquitos, of which there are several species even in the same district. Their terrible power is scarcely to be realized in this country. In his *Five Years in Bulgaria*, Mr. H. C. Barkley relates the following incident :

‘I was told by the captain of a Turkish ship, that one night, while anchored on the Danube opposite a Moldavian village, he had heard piercing screams in a woman’s voice, which gradually grew fainter and fainter, until they died away in about three hours. During the darkness, he was not allowed to land on that shore, but next morning he inquired about it, and was told :

“Oh ! it was a mere nothing. We were keeping a feast-day, and a man who was drunk thought that if he stripped his wife naked and tied her to a tree close by, all the mosquitos would go to her, and not annoy him. He did so, but it was of no use, for he was bitten as badly as before.”

“ But what of the woman ? ”

“ Oh ! the mosquitos killed her. ” ’

These tiny but terrible insects have even been known to kill mules which were tethered near a river, so that it was no wonder that the poor woman died. Yet those which gorged themselves with the poor woman’s blood were not one millionth part of those which never tasted blood in their lives.

I have reason to believe that neither the mosquito, nor even our common gnat, which is a very near relative of the mosquito, makes more than one meal of blood, dying soon afterwards. So it is with the harvest-mite, which is necessarily precluded from making a second attack,

as it dies in the burrow which it has made. Blood, therefore, is not the natural food of the harvest-mite.

What, then, can be the instinct which urges it to attack the higher animals? Why should it be possessed of the power of burrowing under the skin, when not one in many millions has the opportunity of doing so, and those few which do succeed die speedily in the skin which they have penetrated? No solution of these problems has as yet been propounded, and the life-history of the harvest-mite is so far a mystery.

I believe that no cure has been found for the intolerable irritation caused by these tiny creatures, it being due, not so much to injected poison, as is the case with the gnat-bite, but to the mechanical action of the limbs, which are brought in contact with the delicate nerves of the skin. Prevention, however, is better than cure, and if we should be obliged to tread in infested spots, we may as well try to keep the harvest-mites out of our skins. I have already shown that no clothing is proof against them. But it might be possible to protect ourselves by rubbing upon the skin some material which would repel the mite.

When I was staying in the New Forest, I was at first nearly driven out of it by the many insects which feast on human blood. Afterwards, however, I enjoyed complete immunity from their attacks. Before entering the forest I used to rub my hands, neck, face, and ankles with paraffin, carrying with me a small bottle wherewith to renew the paraffin when the potency of its odour began to decrease.

Not an insect would touch me, and even the great gad-flies, which formerly charged with a loud hum, and drove their long beaks through a suit of the strongest

Scotch tweed, dared not come within reach of the area which was charged with the odour of the paraffin. It was quite amusing to watch their behaviour. They would begin their charge as usual, but when they came within range of the paraffin—say, two feet or so—they suddenly swerved, and darted off at right angles. I therefore think that if the ankles and hands were rubbed with paraffin, the harvest-mites would be as effectually baffled as were the more powerful gad-flies. Of course, the odour of the paraffin is not, especially at first, grateful to ordinary human nostrils ; but one soon becomes used to it, and it is better to endure an unpleasant odour for a time than to suffer from the irritation, which is sometimes so violent as to throw the sufferer into a fever. French beans and chalk downs will thus lose their terrors, and it will be possible to gather the one or take a walk on the other without suffering from the tortures of the harvest-mite.

CHAPTER XXX

THE WILLOW AND ITS DENIZENS

IF there be one tree which we are nearly certain to find upon the bank of any brook, it is the common Willow, a tree which loves to drive its roots into water.

The willow, especially when it attains old age, is a veritable treasure-house for all lovers of nature. Its denizens are so numerous that it will be impossible to describe more than one or two of the most conspicuous inhabitants, the leaves, the bark, and the interior of the tree being alike prolific. Let us take the leaves first.

An old willow is easily climbed, especially if it has been 'pollarded.' So ascend it, and examine its leaves carefully, taking one branch at a time, and scrutinizing every leaf in order. In the course of a day's search you will be tolerably certain to find two singularly interesting caterpillars, which in due time will be developed into two of our most striking moths.

The Puss Moth.—One of them, the common Puss moth (*Dicranura vinnula*), is shown in the accompanying illustration. On account of its peculiar form it cannot be mistaken for any other insect. Its colour varies much according to age; but in a nearly full-fed specimen, such as is shown in the illustration, the body is mostly green, with a whitish double line drawn diagonally from the

hump to the head and tail. When viewed from above, the lines form a 'St. Andrew's cross.' There are also some longitudinal stripes of purple brown.

When the caterpillar is at rest, the head is withdrawn into a kind of socket, as seen in the illustration; but when it feeds, the creature can protrude its head to a considerable distance, and so completely alter the contour of the body.

The two remarkable projections at the end of the body are hollow, and from each of them can be protruded a slender pink filament. The caterpillar can mostly be induced to exhibit these filaments by gently 'prodding' it on the hump. The filaments are then protruded, brandished for a moment like whip-lashes, and then withdrawn into their sheaths.

. It is a remarkable fact that if several of these caterpillars be kept in the same vessel, scarcely any of them will retain these tail-spikes intact.

Often this caterpillar loosens the grasp of its six true legs, holds tightly to the branch with its eight claspers (or false legs), bends its body upwards, and remains motionless in a sphinx-like attitude.

The middle of July is the best time to search for these caterpillars, as they will be nearly full-fed, and will therefore escape many of the dangers incident to all caterpillars which are artificially reared.

Judging from the large size and bright colours of the caterpillar, any one who is not familiar with it in its own domains would naturally imagine that it must be very conspicuous and easily found. This, however, is not the case, for when it is upon the branches, among the broken lights, it so closely resembles the leaf of the tree on



Male Puss-moth and Caterpillar.

which it lives, that a practised eye is needed to detect it.

Now comes an interesting episode in the life-history of the caterpillar. It is about to assume the pupal form, and needs to prepare a cocoon in which it can safely pass the winter months. This cocoon is formed in a very remarkable manner. The caterpillar leaves the branches and descends to the trunk, where it hunts about for a convenient crevice in the rough bark, and therein ensconces itself. It then nibbles little bits of bark, mixes them with a liquid cement, of which it has an abundant supply, and with this mixture of animal and vegetable matter forms a sort of case in which it lies concealed. As the case is chiefly formed from bark, it so exactly resembles the trunk of the tree, that even the most practised pupa-hunters are often deceived.

When first made, the case is soft and pliable; but when it is dry, it is so hard that I have known a penknife broken in the attempt to cut open one of these cocoons. Hard as it is, it finds one creature which has no difficulty in penetrating its walls. This is one of the larger ichneumon flies (*Ophion luteum*). The female is furnished with a very long ovipositor, looking like a slender bristle attached to the end of her body. With this apparently insufficient instrument she bores a hole through the cocoon, and introduces one or two eggs into the body of the inmate. As is the case with all the ichneumons, the parasites thrive at the expense of their host, who dies in its cell, leaving the ichneumons to issue into the world and search for more prey.

The cement of which I spoke is exceedingly strong, even without the admixture of the vegetable matter. The

first specimen that I ever took I placed upon a stone mantelpiece, and covered it with a glass tumbler. The caterpillar happened to be about to assume the pupal form, and therefore was obliged to make a cocoon. But the glass and stone afforded no vegetable matter, and so the creature was reduced to depend on the cement alone. With this cement it formed a cell close to the edge of the glass, thus fastening the tumbler to the stone. I allowed it to remain there until the moth was developed, an event which took place sooner than usual, the development being hastened by the warmth of the fire throughout the winter months.

These cocoons are almost always to be found between three and five feet from the ground.

The colour of the moth is simply black and white, arranged in the rather complicated pattern which is shown in the illustration. The body is covered with long, soft, fur-like plumage, something like the fur of a Persian cat. Hence the name of Puss moth.

The Red Underwing Moth (*Catocala nupta*).—For this we must ransack the bark of the willow, and must exercise the sense of touch more than that of sight. It is one of our finest moths. Its expanse of wing is nearly three and a half inches, and the lower wings are bright red, banded with black, so that it seems, when its wings are spread, to be a most conspicuous insect. But, except when disturbed, it never does spread its wings by daylight, being one of the many moths that only fly by night.

During the daytime it sits on the trunk of the willow just below the branches, its brown, mottled upper wings entirely concealing the bright hues of the lower wings,

and being coloured exactly like the willow bark on which the moth is sitting.

I was greatly surprised on the discovery of the first red underwing that I ever saw. I was a very small boy, and was climbing one of the willows on the banks of the Cherwell, near Oxford, for the purpose of diving from its top. Suddenly my finger came upon something soft, and out flew a young underwing, nearly hitting me in the face, and startling me so much that I almost lost my hold of the tree.

Oddly enough, the caterpillar has the same habits as the moth, hiding itself in the crevices of the bark by day, and coming out by night to feed upon the leaves. The best way to find it is to trust to the fingers. Ascend the trunk as far as the junction of the branches, and then feel carefully every inch of the bark for a foot or eighteen inches below the branches. Now and then you will find yourself touching something softer than the bark, and this will almost certainly be the caterpillar of the red underwing. It is not easy to see, its ashen-grey body mostly marked with two broken dark stripes, almost exactly matching the characteristic markings of the willow bark. Even when it is discovered it is not easily removed. The claspers maintain so firm a hold that it is difficult to loosen their grasp without injuring the caterpillar. The safest plan is to take a knife and cut away the bark all round the creature, so as to remove bark and caterpillar together.

When it is about to change into a pupa, it spins a soft silken cocoon, which is quite as inconspicuous as the caterpillar itself. Mostly, it takes advantage of the bark-crevice, in which it lies concealed during the day,

and covers itself in with a mass of loosely woven brownish threads, scarcely distinguishable from the bark, especially under the shadow of the branches. Sometimes, however, it ascends the branches and draws a number of leaves together with its threads, and under their protection it weaves its cocoon.

These two moths belong to the leaves and bark—*i.e.* to the exterior of the tree. Now we will take one which passes the whole of its larval and pupal existence within the tree.

The Goat Moth.—When a willow has become old, venerable, partly hollow, and with the interior wood decaying and turning to the ‘touchwood’ so beloved by boys, there will almost invariably be found the Goat moth (*cossus ligniperda*). The popular name is derived from its powerful and peculiar odour, which, to human nostrils, is of a most disagreeable character, and is so powerful that it can be perceived at a considerable distance from the tree.

Some years ago I was visiting a neighbourhood entirely unknown to me, and as some of us were going to church on a Sunday morning I suddenly exclaimed, ‘There is a goat moth somewhere near.’ So it was. By the side of the road was a small pond, and close to it was growing a remarkably tall willow, which I had not noticed, being engaged in noting the architecture of the church. On going up to the tree, several large holes showed clearly the spot whence the odour proceeded.

Although this characteristic emanation is possessed by the moth, it is much more powerful in the caterpillar. This creature is quite unique in appearance, and cannot be mistaken for any other larva. Its body is reddish

brown and very shining, so that it looks as if it were made of polished mahogany. The head is black, horny, rather flattened, and armed with a pair of jaws of prodigious strength. With these jaws it not only bores into solid wood, but cuts it into little fragments, on which it feeds.

On one occasion a goat moth caterpillar had been captured and was placed upon a piano, a weighted tumbler being inverted over it. Next morning the glass was in its place, but the caterpillar was gone, a hole in the case of the piano betraying its mode of escape. Not only had it bored a hole completely through the hard mahogany of the case, but it was found enjoying itself immensely among the softer woods of which the internal mechanism is constructed. When placed in a metal box furnished with a lid made of perforated zinc, it has been known to force its way out by sheer strength of jaw. It inserted the jaws through two contiguous holes, and, by means of biting and twisting, broke them into one. It then set to work upon another pair of holes, and so proceeded until it had made an aperture through which it could force its wedge-shaped head, followed by its smooth and slippery body.

It lives for three years within the tree, until it has become as long and thick as a man's finger, and then prepares to undergo its change into the pupal state. (I may here mention that, like many other wood-boring insects, the goat moth is exceedingly variable in size, the dimensions depending on the character and amount of the food.) Like the puss moth caterpillar, it then makes a cocoon, interweaving its silk with chips of nibbled wood. As, however, it is not exposed to the

weather and the attacks of foes, as is the case with the puss moth, but remains within the trunk of the tree, it does not need to possess strong walls, and accordingly is quite soft of texture.

On splitting open the trunk of an old willow, several of these cocoons can mostly be found. They are always saturated with the characteristic odour, which adheres with wonderful pertinacity. I have kept specimens for more than twenty years, and have found that even at the expiration of that period the odour was quite as strong as when they were first removed from the tree.

The Rose Beetle.—Still keeping to the interior of the tree, we shall often find two typical and very handsome beetles. If the tree be old, hollow, and producing touchwood, take a mallet and strong chisel, and cut a large hole into the interior, as near the ground as possible. There you will find a quantity of wood-dust, little chips, and similar débris. Remove it very carefully, and sift it through your fingers, so as not to leave a pinch of it unexamined. In it you will probably find some white, fat, thick-bodied grubs, lying half bent, as shown in the illustration. With them you will probably find some cocoons loosely made of silken threads and wood-chips, and there will in all probability be seen one or two broad, rather flat beetles of a brilliant green. These are the lovely Rose beetle (*cetonia aurata*), in three of its stages of existence.

The perfect insect is of a lovely shining green glossed with gold, and having a number of whitish spots scattered over the upper surface. It is furnished with a pair of ample wings, and flies with nearly as much readiness as the ladybird.



Rose-beetle.

One remarkable point in its flight lies in the structure of the wing-cases, or 'elytra.' As a rule, when a winged beetle flies, the elytra are held aloft and rather widely spread. But the elytra of the rose beetle are deeply grooved at each side, so that the wings can be spread and refolded while the elytra remain almost unmoved. This peculiarity is well shown in the illustration.

It is especially fond of the wild rose, and may often be found in the very centre of the flower. It is not so partial to cultivated roses, the stamens having been artificially converted into petals. The white roses, however, still possess a charm for it, and I have often captured it while sitting in the centre of a white rose.

The larva feeds on various vegetable substances, seeming to prefer decaying wood to anything else. Hence, it is often found in the nests of the wood ant, feeding upon the decaying sticks, leaves, grass-stems, and other similar materials of which the dome of the nest is formed. The ants do not trouble themselves about it, as it never moves about, but lies quietly in one place until it emerges as a beetle. From this singular custom it has derived the name of 'king of the ants.'

You will seldom find a solitary example of the larva, or cocoon, of the rose beetle (or 'rose-chafer' as it is sometimes called), a dozen or more specimens being gathered together in the same spot.

The Musk Beetle (*Callichroma moschata*) is the last inhabitant of the willow for which we can find space. This beetle is even more beautiful in colour than the rose beetle, and infinitely more graceful in form and movements.

Like the goat moth, the musk beetle exhales a very potent odour, which, instead of being so nauseous as to be deserving of the name of stench, is a pleasant perfume. I cannot, however, admit that it bears the least resemblance to musk. It is more like sweetbriar, but it has a peculiar character of its own, which, when once experienced, can never be mistaken.

As has been narrated of the goat moth, the presence of the musk beetle can be detected at a considerable distance, and I have often been guided to it simply by its scent. One of these experiences had rather a ludicrous side. I was then living at Belvedere, and two young ladies were staying with us. One morning, as we were out for a walk, I noticed the peculiar perfume of the musk beetle, and casually mentioned the fact. The visitors, who were pure Londoners, refused to believe me, and laughed me to scorn. We returned by the same road, but on the opposite side. When they entered the house, the ladies took off their hats, and by so doing afforded me a triumph. In those days, ladies wore their hair in nets, and these girls had nets made of thick, loose wool. Clinging to the net of one of them was a fine musk beetle, which had evidently been disturbed from the hedge along which we had been walking, and flown for refuge to the nearest shelter.

It is impossible to mistake this beautiful insect. Its whole body and limbs are rich green, glossed with gold, its slender body is about an inch in length, and its extremely long antennæ are continually waved in graceful curves. It has the peculiarity of uttering a squeaking sound when the body is pressed. I believe that it has the power of producing or retaining the odour at will.

In its larva state it burrows into certain trees, the willow being its favourite. I once cut up an old willow tree, and found the whole of it simply riddled with the burrows of the musk beetle, just as a timber which has been long in the sea is riddled with the tunnels of the ship-worm.

HERE, then, is a brief history of some of the inhabitants of the BROOK and its BANKS, viewed practically, and with no pretence to science. Every creature that has been described is plentiful in or on the bank of any brook, and if my readers will try to follow out practically the instructions which have been given, they will be well repaid by their insight into the fairy land of Nature.

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